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PHYSICS ABSTRACTS

SECTION A

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SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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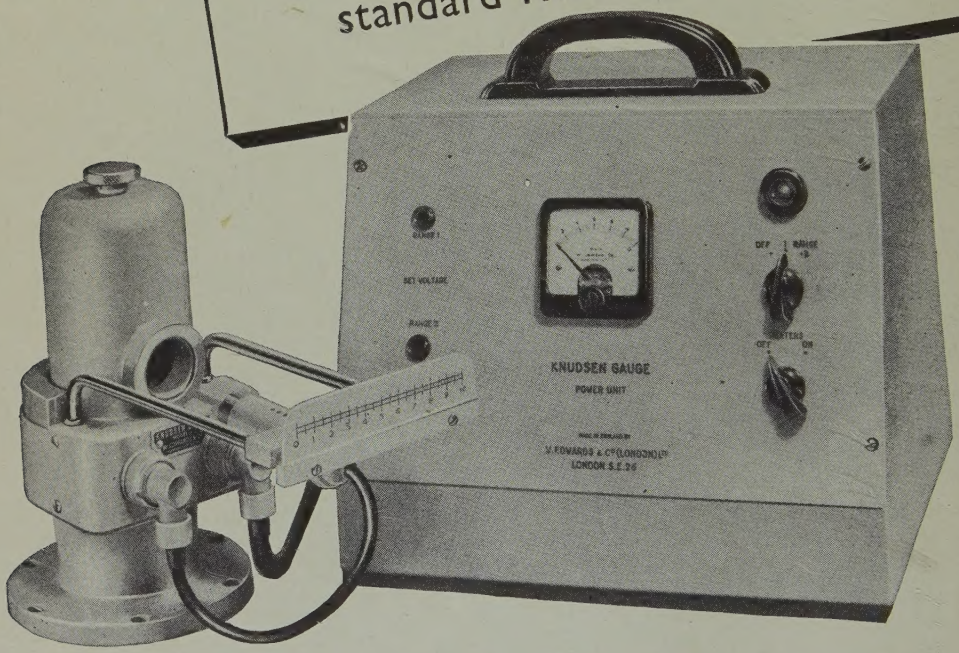

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

Electrical and magnetic measurements and instruments
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Photocells
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Cathode-ray tubes
X-ray tubes
Amplifiers
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953). Reprints of the List of Journals can be obtained from the Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

Bull. Amer. Ceram. Soc.	*Bulletin of the American Ceramic Society.* [Abstracted by Metropolitan Vickers Electrical Co.]
FeinwTech.	*Feinwerktechnik.* [Article reprinted in *Entwicklungsber. Siemens & Halske.*]
J. Amer. Ceram. Soc.	*Journal of the American Ceramic Society.* [Abstracted by Metropolitan-Vickers Electrical Co.]
Mem. Coll. Sci. Univ. Kyoto A	*Memoirs of the College of Science. University of Kyoto. Series A—Mathematics, Physics, Chemistry.* Kitashirakawa, Sakyo-ku, Kyoto.
Mem. Soc. Vaudoise Sci. Nat.	*Memoires de la Société Vaudoise des Sciences Naturelles.* Palais de Rumine, Lausanne.
Metall	*Metall.* [Article reprinted in *Entwicklungsber. Siemens & Halske.*]
Metalloberfläche	*Metalloberfläche.* [Article reprinted in *Entwicklungsber. Siemens & Halske.*]
MittBlatt math. Statist.	*Mitteilungsblatt für mathematische Statistik.* [Article reprinted in *Entwicklungsber. Siemens & Halske.*]
Nature [Paris].	*La Nature.* [Abstracted by *Rubber Abstracts.*
Natuurwet. T.	*Natuurwetenschappelijk Tijdschrift.* [Abstracted by *British Abstracts.*]
Paper Industr.	*Paper Industry.* [Abstracted by Metropolitan-Vickers Electrical Co.
Prod. Engng	*Product Engineering.* [Abstracted by Metropolitan-Vickers Electrical Co.]
Publ. Inst. Roy. Météorol. Belgique	*Publications. Institut Royal Météorologique de Belgique.* 3 Avenue Circulaire, Uccle 3 (nr. Brussels), Belgium.
Rep. Ionosphere Res. Japan	*Report of Ionosphere Research in Japan.*
Publ. Nat. Res. Coun. Nat. Acad. Sci. U.S.A.	*Publications of the National Research Council of the National Academy of Sciences of the United States of America.* 2101 Constitution Avenue, Washington 25, D.C.
Rev. gén. Caoutchouc	*Revue Générale du Caoutchouc.* [Abstracted by *Rubber Abstracts.*]
Rev. Un. Mat. Argentina	*Revista de la Union Matemática Argentina.* Institute de Matemática, Perú 221, Buenos Aires.
Sheet Metal Industr.	*Sheet Metal Industries.* [Abstracted by Metropolitan-Vickers Electrical Co.]
Svensk kem. T.	*Svensk Kemisk Tidskrift.* [Abstracted by *British Abstracts.*]
Trans Inst. Radio Engrs Prof. Group	*Transactions of the Institute of Radio Engineers Professional Groups.* [Papers published by individual Professional Groups of the Institute.] 1 East 79th Street, New York 21.
Wiss. Z. Tech. Hochsch. Dresden	*Wissenschaftliche Zeitschrift der Technischen Hochschule Dresden.* Mommsenstrasse 13, I, Dresden, A.27.
Z. Metallk.	*Zeitschrift für Metallkunde.* [Article reprinted in *Entwicklungsber. Siemens & Halske.*]

MATHEMATICS 51

518.12

576. Numerical analysis. D. R. HARTREE. *Oxford, Clarendon Press* (1952) 287 *pp.*

This introduction to modern numerical methods provides a valuable guide to the theory and practice of systematic computation, and contains much practical advice on detailed methods of procedure. The emphasis throughout is on the development of results in forms best suited for practical calculation; an important feature of the book is the attention paid to checking procedures and the detection of mistakes. Many recent developments are discussed and a bibliography provides suggestions for further reading. The book is chiefly concerned with calculations made on desk machines, but a final chapter provides an introduction to work with automatic digital calculators. The chapter headings are: the tools of numerical work and how to use them; evaluation of formulae; finite differences; interpolation; integration (quadrature) and differentiation; integration of ordinary differential equations; simultaneous linear algebraic equations and matrices; non-linear algebraic equations; functions of two or more variables; miscellaneous processes; organization of calculations for an automatic machine. R. A. NEWING

518.5 : 621.317.79

577. Electronic analog computers. G. A. KORN AND T. M. KORN. *New York, London: McGraw-Hill* (1952) 378 *pp.* Review in *Science*, **116**, 371–2 (*Oct.* 3, 1952).

519.2 : 621–526

578. Some statistical problems in the theory of servomechanisms. M. SUNDSTRÖM. *Ark. Mat.*, **2**, *Paper* 8, 139–246 (1952).

The author studies the following statistical problems which are connected with servo theory but otherwise distinct: errors and error-smoothing, transfer functions, inverse Laplace transforms, the effect of omitting input frequencies, probability distributions of input and output, noise in linear systems, autocorrelations and spectral densities, noise and the quantity of information, servo-circuits defined by linear differential equations with non-constant coefficients containing random parameters. Many numerical examples are given. T. J. REY

ASTRONOMY . ASTROPHYSICS . GEODESY 52

522.29 : 535.83

579. Optical problems at the Palomar Observatory. I. S. BOWEN. *J. Opt. Soc. Amer.*, **42**, 795–801 (*Nov.*, 1952).

The great flexibility of the 200 in. mirror required the development of new and elaborate support systems to maintain the figure in all orientations. New methods had, therefore, to be devised for testing the mirror in the telescope while on these supports. The final figuring was done on the mountain on the basis of these tests. To increase the effectiveness of the instrument, corrector lenses were designed by Ross greatly to enlarge the field of the main mirror. Likewise the method of evaporating a reflecting coat of aluminium was developed by Strong to replace the old silvering procedures. Several new optical designs were introduced in the spectrographs to make optimum use of the light collected. These included the use of (1) a composite of four "blazed" gratings to permit a collimator aperture of 12 in.; (2) Schmidt cameras with half-strength corrector plate placed practically in contact with the grating, the light passing through the plate twice (this eliminates many vignetting problems and permits higher speeds and larger fields); and (3) a combination of a quartz aplanatic sphere with a Schmidt camera for the shortest focal-length camera to obtain a much higher speed ($F/D = 0{\cdot}7$) than would otherwise have been possible. A.

523.112

580. On the expansion of the universe. II. F. ZAGAR. *R.C. Accad. Naz. Lincei*, **12**, 239–45 (*March*, 1952) *In Italian.*

Continuing a discussion based on Newtonian mechanics, a linear recession law is derived for a system in which gravitational attraction is replaced by a repulsive inverse square law of force. Such a repulsion could be provided by radiation pressure, and the conditions under which it could become more important than gravitational attraction are discussed. R. A. NEWING

523.165 : 523.161

581. Line emission from interstellar matter in the radiofrequency range. R. LÜST. *Naturwissenschaften*, **39**, *No.* 16, 372–4 (1952) *In German.*

Recent radio-astronomical observations of regions of the Milky Way on a wavelength *c.* 20 cm [Ewen and Purcell; von Muller and Oort (1951)] have disclosed the existence of areas of high radio "line-emission" in the so-called H I regions. The latter are discussed in relation to the fine-structure emission from the neutral H atom at $\lambda 21{\cdot}2$ cm, and to their association with discrete clouds of interstellar matter. D. R. BARBER

523.53

582. On the nature of the decay of a meteor trail. J. FEINSTEIN. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 741 (*Sept.*, 1952).

The use of the experimental value of radiative recombination in place of the theoretical value leads to the conclusion that the decay of a long-duration trail by simple diffusion would be much slower than the decay due to recombination. It is necessary to consider an additional mechanism, such as the shock-wave suggested by the author, to reduce the rate of recombination in the initial stages and allow the decay to be governed by diffusion and turbulence. The large-cylinder metallic behaviour of Kaiser and Closs,

and Greenhow would apply only during the initial stages of trail expansion. M. W. OVENDEN

523.72 : 538.561

583. Solar "enhanced radiation" and plasma oscillations. H. K. SEN. *Phys. Rev.*, **88**, 816–22 (*Nov.* 15, 1952).

The dispersion relation for a plasma oscillating in a static magnetic field is derived by the Laplace transform method. The plasma oscillations are found to be unstable in frequency bands around multiples of the gyrofrequency. A numerical application to spot magnetic fields at coronal distances indicates sufficient amplification to make plausible the theory of the origin of solar "enhanced radiation" in plasma oscillations of electrons gyrating round the magnetic field of sunspots. A.

523.72 : 551.510.535

584. *E*-region during the solar eclipse of February 25, 1952. C. M. MINNIS. Letter in *Nature* [*London*] **170**, 453 (*Sept.* 13, 1952).

Preliminary report, analysing f_0E measurements made at 4 min intervals at Khartoum around eclipse totality. It is concluded that the ionizing radiation is non-uniformly distributed over the solar disk, and that it is consistent with the intensity distribution of the green coronal line except just after totality, when there appears to be an additional intense source of ionizing radiation near the W. limb of the sun.

G. M. BROWN

523.746

585. New photometric observations of sunspots. R. MICHARD. *C.R. Acad. Sci.* [*Paris*] **235**, 791–3 (*Oct.* 13, 1952) *In French.*

The material provided by 250 sunspot spectra, within the spectral range 6700 Å–3200 Å, has been used to study variations of the ratio (intensity at centre of spot/intensity of surrounding photosphere) as function of wavelength, distance of spot from centre of disk, and size of spot. Reduced intensities have been freed from (*a*) effect of bad centering of spot on spectrograph slit, and (*b*) scattering of photospheric light into spot image by optical system employed.

D. R. BARBER

523.747

586. The average life of facular granules, and luminous areas in the penumbra of sunspots. C. MACRIS. *C.R. Acad. Sci.* [*Paris*] **235**, 868–9 (*Oct.* 20, 1952) *In French.*

Analysis of 72 drawings made from high-magnification cine-records of sunspots (solar diameter = 267·5 cm) reveal two distinct types of luminous granulations with very different average durations. The first group consists of granules observed on the photosphere, and in faculae—the mean life being between 6 and 8 min only. The second, found only in spot penumbrae, indicates a much longer mean duration, the identity of individual features being preserved for periods > 30 min. D. R. BARBER

523.852.3

587. On the variation of the colour index and gradient of extragalactic nebulae. E. VANDEKERKHOVE. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 4, 478–94 (1952) *In French.*

Resultant gradients are calculated for photographic and visual regions for different types of stellar populations. The measurements of Stebbins and Whitford could be accounted for by allowing for interstellar absorption and for the evolution of giant stars toward the main sequence. R. A. NEWING

523.877 : 539.172.13

588. Nuclear reactions in the stars. I. Proton-proton chain. E. E. SALPETER. *Phys. Rev.*, **88**, 547–53 (*Nov.* 1, 1952).

The rates are calculated for the main reactions making up the "proton-proton chain," whose net effect is the conversion of 4 H atoms into 1 He atom. These calculations are carried out for temperatures and densities corresponding to central conditions in main sequence stars. The mean reaction rate for the β-decay conversion of two protons into one deuteron is calculated accurately, using the latest data on the two-nucleon system and on β-decay. It is shown that, under normal stellar conditions, the reaction chain is completed by the radiative capture of a proton by a deuteron and by the collision between two of the resultant He^3 nuclei to form one He^4 nucleus and two protons. Values are given for the rate of energy production and for the concentrations of D and He^3 at various temperatures. A.

526.1

589. On the fundamental problem of dynamical geodesy. I. L. BRAGARD. *Bull. Soc. Roy. Sci. Liège*, **21**, 247–58 (*April–May*, 1952).

Shows that the relation between the elevation of the geoid, Δr, and the anomaly of gravity, Δg, can be expressed as an integral equation of Fredholm type, of which the solution is Stokes's relation between Δr and Δg when the geoid and reference surface enclose the same volume and have the same centre of gravity. If the iterative solution, which converges, is taken to the second term in these circumstances, the error does not exceed 25%. When the centres of gravity do not coincide, the iterative solution is not convergent; this situation will be discussed in a further note. A. H. COOK

PHYSICS 53

53

590. On definitions in the teaching of physics. Z. V. CHRAPLYVY. *Amer. J. Phys.*, **20**, 562–5 (*Dec.*, 1952).

Reasons are discussed why certain rigorous definitions of physical quantities appear to be too difficult for the average student. A general criterion for pedagogically satisfactory definitions is proposed and illustrated by several examples; in particular, the definition of the magnetic field vector B by means of the Lorentz force is discussed in some detail. Remarks are added on the use of auxiliary "paradefinitions." A.

53.081.5

591. Dimensions and units. M. BERGER. *C.R. Acad. Sci.* [*Paris*] **235,** 872–4 (*Oct.* 20, 1952) *In French.*

Voltage is given the dimensions $[ML^{-1}T^{-2}]$ and thus the mechanical system [MLT] is made to cover also electrical quantities. It is suggested that the M.K.S. system be used as the most convenient system of units, the choice of which is an independent question. S. WEINTROUB

53.081.5

592. On the use of dimensional analysis in general physics. J. S. MILLER. Letter in *Amer. J. Phys.*, **20,** 520·1 (*Nov.*, 1952).

It is stressed that the teacher should illustrate the method of establishing a formula by dimensional analysis rather than repeat textbook examples. The author outlines how he would treat the simple pendulum. S. WEINTROUB

53.087.6 : 621.317.7.087.6

593. Recording instruments with inkless recording. W. OESINGHAUS. *AEG Mitt.*, **42,** 188–90 (*July–Aug.*, 1952) *In German.*

In these instruments the recording of the quantity measured is accomplished by burning out a trace from the chart on to which a thin film of Zn or Cd has been evaporated. They are therefore particularly suitable for the simultaneous writing side by side of several measured quantities, for very high speeds of chart feed and for measuring systems having a very short time of orientation, e.g. between 20 and 100 msec. The ink pen is replaced by a thin point-electrode lying tightly on the metal layer. A spring or roller gliding on the metal film serves as second electrode. The voltage applied is 18–24 V. The metal layer is fused off point by point by the small arc produced at the point electrode. This system has advantages in recording in factories and power stations. R. NEUMANN (R)

FUNDAMENTALS 530.1

530.12

594. Gravitational field of a point mass in arbitrary motion according to Birkhoff's theory. C. GRAEF FERNÁNDEZ. *Rev. Mexicana Fís.*, **1,** 11–27 (*April*, 1952) *In Spanish.*

The field is first obtained for a particle moving uniformly relative to an inertial frame, and then generalized on the assumption that it is independent of the acceleration of the particle. The potentials, expressed in terms of retarded position and velocity 4-vectors, have the form $m(2v_iv_j - \eta_{ij})/|p|$, where η_{ij} is the metric tensor for flat space-time. R. A. NEWING

530.12

595. Non-planar orbits of a particle in the field of a rotating sphere according to Birkhoff's theory. F. ALBA ANDRADE. *Rev. Mexicana Fís.*, **1,** 38–43 (*April*, 1952) *In Spanish.*

The equations of motion in G. D. Birkhoff's flat space-time theory of gravitation are solved to the 1st order of approx. for small velocities. A particle moving approx. in a circular orbit is found to have a small acceleration perpendicular to the plane of the orbit. The effect is too small for observation but might have applications in cosmology. R. A. NEWING

530.12 : 530.145

596. Relativity and indeterminacy. G. W. SCOTT BLAIR; C. O. HINES; H. BONDI AND T. GOLD. Letters in *Nature* [*London*] **170,** 582–3 (*Oct.* 4, 1952).

Continuation of discussion on the implications of a maximum speed of propagation [see Abstr. 5520 (1952)]. R. A. NEWING

530.12 : 531.18

597. New kinematical considerations on special relativity. Q. MAJORANA. *R.C. Accad. Naz. Lincei*, **12,** 245–51 (*March*, 1952) *In Italian.*

See Abstr. 751 (1952).

530.14

598. Elementary particles at rest. E. BUSTAMANTE. *Phys. Rev.*, **88,** 1179–81 (*Dec.* 1, 1952).

The object of this paper is to present a theory of the structure of elementary particles at rest. Some applications are included; in particular a solution to an unsolved problem in astronomy is presented. A.

530.145

599. Relativistic Fourier reciprocity and the elementary masses. E. SCHRÖDINGER. *Proc. Roy. Irish Acad. A*, **55,** *No.* 2, 29–50 (*May*, 1952).

Reciprocal functions are sub-divided into four classes and a generalization is introduced to ensure that integral and Lorentz transforms commute. These conceptions are employed in a discussion of wave-operators, and it is concluded that the demand for Fourier reciprocity is not sufficiently restrictive to provide a theory of rest masses. R. A. NEWING

530.145

600. On the physical interpretation of the quantum theories. J.-L. DESTOUCHES. *J. Phys. Radium*, **13,** 385–91 (*July–Aug.–Sept.*, 1952) *In French.*

For micro-system S and measuring apparatus α, a deterministic description of the pair (S/α) can be given using hidden parameters. However, if the observer makes no measurement, the system must be described in a unitary theory, taking the whole universe into account, which leads to a complementarity between objective description and a description taking account of the observer's measuring actions. Proposals for the unification of quantum and unitary theories are outlined. R. H. DALITZ

530.145

601. Reality problem in quantum mechanics. O. COSTA DE BEAUREGARD. Letter in *Amer. J. Phys.*, **20,** 593 (*Dec.*, 1952).

It is pointed out that an apparent paradox in Epstein's treatment of this subject [Abstr. 2741 (1945)] disappears when the geometry of the situation is considered. A. J. MEE

530.145

602. Quantum mechanics of particles and wave fields. A. MARCH. *New York, John Wiley; London, Chapman and Hall* (1951) x + 292 *pp.*

Review in *Nature* [*London*] **170,** 727 (*Nov.* 1, 1952).

530.145

603. "Infra-red catastrophe"-like divergency in meson-decay process. D. Itô. Letter in *Progr. theor. Phys.*, **6**, 1020–2 (*Nov.–Dec.*, 1951).

The cancellation of divergencies is demonstrated in the case of a charged scalar particle decaying into a charged and a neutral scalar particle by simultaneous consideration of elastic scattering and decay with double scattering. W. J. SWIATECKI

530.145

604. On the divergence of the transition probability due to energy conservation in intermediate states. D. Itô. Letter in *Progr. theor. Phys.*, **6**, 1023–4 (*Nov.–Dec.*, 1951).

A generalized form of the "reciprocity relations" ensuring the cancellation of divergencies coming from different processes is given by considering the form of the expressions for transition probabilities in the vicinity of poles. See also preceding abstract. W. J. SWIATECKI

530.145

605. Relativistic theory of free three-dimensional particles. Yu. M. Shirokov. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 539–43 (1952) *In Russian.*

Despite the wide-spread opinion, shared by such authorities as Pauli and Wentzel, that the postulate of relativistic invariance represents an insurmountable barrier to the evolution of a theory of free 3-dimensional particles, it may be shown that this is not the case. Wentzel believes that eigen-energy and eigen-impulse of the proton do not transform like a 4-vector, Pauli that in the transition to a moving co-ordinate system time enters into the structure of a 3-dimensional particle. Assuming a particle described by an energy-impulse tensor $T_{ik} = u_i u_k \rho_0(y_i)$ where $y_i = x_i + u_i u_j x_j$ and $i, j, k = 1, 2, 3, 4$; u_i is the 4-velocity of the particle as a whole, ρ_0 the invariant density characterizing the distribution of matter. This tensor may be shown to be covariant and to be reduced to a single component in a system at rest. Hence the classical method of treatment, viz. to assume the particle as consisting of distributed matter held together by forces, may also be applied to the relativistic case, provided the characteristics of matter, form and magnitude of the forces are appropriately chosen. In the classical case all the internal forces are balanced and theory agrees with experimental facts. In the relativistic case of a charged particle T_{ik} changes its form and does not remain covariant unless non-Maxwellian forces (Poincaré pressures) are introduced which actually not only make T_{ik} covariant, but also conserve its form. On this principle the modelling of a 3-dimensional relativistic particle succeeds without contradictions. B. F. KRAUS

530.145

606. Fourth-order vacuum polarization. M. Baranger, F. J. Dyson and E. E. Salpeter. Letter in *Phys. Rev.*, **88**, 680 (*Nov.* 1, 1952).

Calculation of the vac. pol. contribution to the 4th-order radiative correction to the motion of a slow electron in an external field is reported. Its ratio to the zero order scattering amplitude is $(41/162)(\alpha/\pi)^2(q^2/m^2)$ for small momentum transfer q, and it contributes $-0{\cdot}239$ Mc/s to the Lamb shift for hydrogen and deuterium. R. H. DALITZ

530.145

607. Contributions to field-mechanics. E. Grosschwitz. *Z. Naturforsch.*, **7a**, 458–65 (*July*, 1952) *In German.*

The condition for the convergence of the series expansion of $F(Q)$, the 1st order structure function of Bopp's linear electrodynamics [Abstr. 4693 (1950)] is obtained; previously chosen functions have not satisfied this condition. $F(Q)$ is calculated in closed form for the choice $\delta(\sigma + a^2)$ for the form function $f(\sigma)$. The micro-motion and self-energy of a charged particle is discussed for the circular path model, attention being given to the approach to the light velocity limit. R. H. DALITZ

530.145

608. The current density in quantum electrodynamics. H. C. Corben. Letter in *Phys. Rev.*, **88**, 677 (*Nov.* 1, 1952).

For the relativistic equation $[\gamma_i D_i + i(e/e_0)\kappa\gamma_5]\psi = 0$ which describes electrons, positrons and neutrinos, two pseudovector current densities $ec\psi^\dagger\gamma_i\psi$ and $-\frac{1}{2}i(e_0\hbar/m_0)(\psi^\dagger\gamma_5 D_i\psi - D_i^*\psi\gamma_5\psi)$ are found. The relations between them and between the Maxwell fields they generate are discussed. R. H. DALITZ

530.145

609. Compton operator. J. M. Lozano and F. M. Medina. *Rev. Mexicana Fis.*, **1**, 44–51 (*April*, 1952) *In Spanish.*

This "two-vertices" operator (it has two vertices in a Feynman diagram) occurs in the calculation of the 4th-order radiative corrections to the Compton effect. Its form is worked out by application of Dyson's rules. L. PINCHERLE

530.145

610. Anomalous magnetic moments of nucleons. I. F. E. Prieto. *Rev. Mexicana Fis.*, **1**, 64–77 (*April*, 1952).

In this preliminary paper the Tomonaga–Schwinger formalism is applied to the calculation of the electromagnetic and mesonic self-energy of nucleons interacting with an e.m. and a pseudoscalar (neutral, charged and symmetrical) meson field. Both self-energies have a logarithmic divergence and can be eliminated from the equations of motion by a method similar to that employed by Schwinger to eliminate the self-energy of the electron. L. PINCHERLE

530.145

611. Generation of pairs of π-meson on nucleons. G. F. Zharkov. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 677–86 (1952) *In Russian.*

The generation of a pair of pseudoscalar mesons by a photon on nucleons is investigated in pseudoscalar and pseudovector interaction. The results show that whereas in single meson generation by a photon the two interactions are equivalent, the pseudovector interaction leads in the case of meson-pair formation to a considerably smaller cross-section (in the most interesting energy range) than the pseudo-scalar interaction. The angular distribution of the generated mesons differs for the two kinds of

interaction. The effective sections for pair-formation on a proton and neutron are almost equivalent in magnitude and angular relation. B. F. KRAUS

530.145 : 539.17

612. The effect of charge symmetry on nuclear reactions. N. M. KROLL AND L. L. FOLDY. *Phys. Rev.*, **88**, 1177–9 (*Dec.* 1, 1952).

For a charge symmetric nuclear Hamiltonian, the operator which changes neutrons into protons and protons into neutrons (charge parity operator) commutes with the Hamiltonian and is therefore a constant of the motion. Since the charge parity operator anticommutes with the "3" component of the total isotopic spin, for nuclei with $T_3 = 0$ (self-conjugate nuclei) the charge parity is a good quantum number and in the absence of degeneracy the eigenstates of such nuclei have either odd or even charge parity. This leads to strong selection rules in nuclear reactions involving self-conjugate nuclei in the initial and final states which may reasonably be invoked to explain recent experimental results on such reactions. Since states of even total isotopic spin have even charge parity and states of odd total isotopic spin have odd parity, the selection rules arising from charge symmetry often coincide with those of charge independence and in such cases a definitive test of the change independence hypothesis by the use of these selection rules is impeded. Some other applications of the charge symmetry principle are discussed. A.

530.145

613. Tensors whose elements are Dirac matrices. F. L. BAUER. *C.R. Acad. Sci.* [*Paris*] **235**, 793–4 (*Oct.* 13, 1952) *In French.*

A theorem that the orthogonal spin transformations are isomorphic with the symplectic transformations of the Clifford algebra is demonstrated and discussed. R. H. DALITZ

530.145

614. On the zitterbewegung of the Dirac electron. K. HUANG. *Amer. J. Phys.*, **20**, 479–84 (*Nov.*, 1952).

The detailed motion of a free Dirac electron is investigated by examining the expectation values of the position r and of $r \times r$ in a wave packet. It is shown that the well-known zitterbewegung may be looked upon as a circular motion about the direction of the electron spin, with a radius equal to the Compton wavelength (divided by 2π) of the electron. It is further shown that the intrinsic spin of the electron may be looked upon as the "orbital angular momentum" of this motion. The current produced by the zitterbewegung is seen to give rise to the intrinsic magnetic moment of the electron. A.

530.145

615. Laws of transformation of spinors representing solutions of Dirac's equation. I. S. SHAPIRO. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 524–38 (1952) *In Russian.*

It is proved, by considering transformations altering the direction of the lapse of time, that there are four non-equivalent types of spinors satisfying Dirac's equation for particles of spin ½ and a non-zero rest mass. In the case of zero rest mass the number of non-equivalent Dirac spinors is 14. The problem of the so-called conjugate spinors and of the transformation characteristics of the wave functions of particles with integral spin are also considered. Conjugate spinors exist only for two of the 4 non-equivalent spinor types of particles with non-zero rest mass. Five irreducible tensors which may be formed from the components of 2 spinors of the same type are multivectors or quasi-multivectors. The quasi-multivectors are equivalent to the multivectors either with respect to the characteristic, or to the non-characteristic transformations of the Lorentz-group. In particular, the current vector is really a quasi-vector. Applications are made to the interactions of Dirac particles with each other or with zero-spin particles. B. F. KRAUS

530.145

616. On the correspondence theory of the spin wave-equations. R. HAAG. *Z. Naturforsch.*, **7a**, 449–58 (*July*, 1952) *In German.*

Discusses the relation between the representations of the β-matrix algebra in the covariant theory of spinning particles and the physical realizations of the theory. For higher-order point-particle equations approximating the field mechanical model, the correspondence with the Bhabha spin wave-equations still exists, with an increasingly complicated mass operator. R. H. DALITZ

530.145

617. Exchange-collisions of fast nucleons with deuterons. II. I. YA. POMERANCHUK. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 624–7 (1952) *In Russian.*

For Pt I, see Abstr. 4921 (1952). The effective cross section was found for the case where the impulses of slow neutrons are known. Experiments on energy and angular distribution of slow neutrons can be used for the spin-analysis of the exchange forces of fast nucleons. J. JACOBS

530.145

618. Multiple processes in interactions. D. IVANENKO AND V. LEBEDEV. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 638–40 (1952) *In Russian.*

An interaction Hamiltonian in the form of a power series in the meson wave function $\Sigma c_n \Phi^n$ represents multiple meson emission and leads to an interaction potential diverging at the origin as $r^{-(2n-1)}$. W. J. SWIATECKI

530.145

619. Quantum corrections to classical nonlinear meson theory. D. R. YENNIE. *Phys. Rev.*, **88**, 527–36 (*Nov.* 1, 1952).

For a linear Einstein–Bose field of large amplitude it is well known that the classical approximation is quite good for treating certain problems; the validity of this conclusion for the case of a nonlinear field is investigated here. In order to compare the classical and quantized versions of a nonlinear meson theory, the problem of calculating the energy of interaction of the field with a given static source distribution is considered. The quantized theory is treated in such a way that the classical result appears as a first approximation; the quantum corrections then include infinite renormalizations of the original parameters of the theory plus finite corrections to the energy. Part

of these corrections are estimated and are found to become increasingly important with increasing source strength, contrary to the usual assumption. Since only a small part of the total quantum correction can be estimated by the present methods, a complete calculation might give a value very much larger or very much smaller than that given here; nevertheless, it is possible to conclude that the nature of quantum corrections is such that they cannot be treated as small perturbations. A.

530.145

620. The impulse approximation and field theoretical calculations. I. J. S. BLAIR AND B. SEGALL. *Phys. Rev.*, **88**, 621–4 (*Nov.* 1, 1952).

The reaction α + nucleus $\rightarrow \beta$ + nucleons is considered where α and β are particles of quantized fields and the coupling to nucleons is assumed linear in the fields. By an extension of the recent work of Chew and Goldberger [Abstr. 8677 (1952)] on potential scattering, the collision matrix has been manipulated into a term representing the impulse approximation plus three correction terms which are, respectively: the error in the impulse assumption arising from nuclear potentials; the "multiple scattering" which is at least fourth order in the coupling; and finally, a small term representing the effect of lowest order absorption. It is significant that there is no large term present, of the order of the impulse approximation term, which represents processes, second order in the coupling, where one nucleon absorbs α and another nucleon emits β. A.

530.145

621. Meson theory of nuclear forces and low energy properties of the neutron-proton system. M. M. LÉVY. *Phys. Rev.*, **88**, 725–39 (*Nov.* 15, 1952).

A detailed analysis is made of the neutron-proton interaction yielded by the symmetrical pseudoscalar meson theory, with pseudoscalar coupling, using the Tamm–Dancoff nonadiabatic method which has been extended to include nucleon pair creation and higher order effects in the exchange of mesons. It is found that, in the nonrelativistic region, the second- and fourth-order terms provide the main contribution to the interaction, the remaining part of the potential giving only a small correction. In the relativistic region, little can be said about the convergence of the interaction, but there are indications that it becomes strongly repulsive at distances comparable with the nucleon Compton wavelength ($\hbar/Mc$). The radiative corrections to the potential are calculated in the nonrelativistic limit, using the equation of Bethe and Salpeter, which has been transformed into a one-time equation by means of a method which has been given previously. It is shown that the corrections arising from vertex parts and closed loops in the Feynman diagrams are at most of the order of $(G^2/4\pi)(\mu/2M)^2$ times the term which they correct. There exists, however, a class of finite self-energy terms which give a contribution to the interaction having the same analytical form as the fourth-order potential, times a numerical factor which can be expressed as a power series in $G^2/4\pi$. The low-energy properties of the neutron-proton system are discussed, using the nonrelativistic potential which is calculated in this paper, and replacing the interaction in the relativistic region by a boundary condition prescribing that the wave function tends to zero at a finite distance r_c. It is found that a good agreement with experiment can be achieved by choosing $G^2/4\pi = 9{\cdot}7 \pm 1{\cdot}3$ and $r_c = (0{\cdot}38 \pm 0{\cdot}03)(\hbar/\mu c)$. Finally, an investigation of the neutron-proton scattering at 40 MeV shows that the same potential leads to a satisfactory description of the available experimental data. A.

530.145

622. Symmetrical pseudoscalar meson theory of nuclear forces. J. V. LEPORE. *Phys. Rev.*, **88**, 750–1 (*Nov.* 15, 1952).

Nuclear forces yielded by the symmetrical pseudoscalar theory are discussed in terms of a perturbation expansion. It is shown that, up to terms in the square of the coupling constant, the pseudoscalar coupling is equivalent to a scalar pair coupling of the pseudoscalar field plus a pseudovector coupling of that field. The dominant contribution to the fourth-order nucleon potential is then obtained in a simple way by using this result. A.

530.145

623. The electron-neutron interaction as deduced from pseudoscalar meson theory. B. D. FRIED. *Phys. Rev.*, **88**, 1142–9 (*Dec.* 1, 1952).

Pseudoscalar meson theory with pseudoscalar coupling is used to find a value for the electron-neutron interaction. By means of the Feynman–Dyson–Wick techniques, the one-neutron matrix elements of the S matrix are calculated in the usual weak coupling perturbation theory, carried to second order in the meson-nucleon coupling. Expressions for the magnetic moment and the electron-neutron interaction are deduced from this. By using the former to fix the coupling constant, it is found that the potential well representing the latter has a depth of 5380 eV if, as is conventional, this is taken to be square, with a radius of e^2/mc^2. The various results found by previous authors and their relation to the present work are discussed. A.

530.145

624. The effect of final state interactions on reaction cross sections. K. M. WATSON. *Phys. Rev.*, **88**, 1163–71 (*Dec.* 1, 1952).

Particles produced in a reaction often interact strongly with each other before getting outside the range of their mutual forces. Formal effects of such interactions are discussed, and in particular it is shown that the effect for very strong attractive interactions can be calculated explicitly without having detailed knowledge of the properties of the reaction. Application is made to some meson phenomena. A.

530.145

625. Transient effects in scattering by a rigid sphere. M. MOSHINSKY. *Rev. Mexicana Fis.*, **1**, 28–37 (*April*, 1952) *In Spanish.*

The scattering centre is introduced suddenly at $t = 0$. The dependence on time of the scattered s-wave is worked out. These transient effects are compared with those occurring in single-level scattering processes and their relevance to the uncertainty principle is discussed. L. PINCHERLE

530.145

626. Scattering of mesons by mesons. J. DE OYARZABAL. *Rev. Mexicana Fis.*, **1**, 52–63 (*April*, 1952) *In Spanish.*

Dyson's covariant formalism is applied to the meson-meson scattering in a neutral pseudoscalar theory, taking into account radiative corrections (emission and absorption of virtual nucleons). An explicit form is obtained for the terms of 4th order in the coupling parameter. The case of low-energy particles is treated as an example. L. PINCHERLE

530.145

627. A variational principle for scattering. H. FESHBACH AND S. I. RUBINOW. *Phys. Rev.*, **88**, 484–7 (*Nov.* 1, 1952).

A variational principle is presented for the phase shifts δ_l of a central-force scattering problem. This generalizes the principles of Schwinger and Hulthèn for *S*-state scattering in that (*a*) it is applicable to states of higher angular momentum, and (*b*) it depends explicitly on the "inside" wave function only. The Born approximation may be obtained with the choice of an appropriate trial function. Illustrative calculations have been made for the *S*- and *P*-state scattering states for an exponential well nucleon-nucleon interaction potential. A simple one-parameter trial function was utilized. The results are in excellent agreement with previously given exact calculations. A.

530.145

628. Meson-nucleon scattering and the classical strong-coupling theory. D. FELDMAN. *Phys. Rev.*, **88**, 890–1 (*Nov.* 15, 1952).

The ordinary elastic and charge-exchange scattering of mesons by nucleons is considered within the framework of a classical strong-coupling treatment of the charge-symmetric pseudoscalar field. A.

530.145

629. Scattering of charge symmetric pseudoscalar mesons by nucleons. W. W. WADA. *Phys. Rev.*, **88**, 1032–6 (*Dec.* 1, 1952).

The Pauli theory of extended source interacting with the neutral pseudoscalar field with pseudovector coupling has been extended to the case of the charge-symmetric pseudoscalar field, and has been applied to the problem of the scattering of mesons by nucleons. The results of the calculation show that the scattering cross-sections are strongly dependent upon the energy of the incoming mesons, that the cross-section for the scattering of π^+ by protons is larger than that for π^- by a factor 2·25 at all kinetic energies up to about 150 MeV, and that within the scattering of π^- by protons the cross-section for the scattering involving charge-exchange interaction is larger than that with ordinary interaction by a factor which varies from 2·1 to 1·5 as one goes from zero kinetic energy to 150 MeV. When the coupling constant $(f\mu)^2$ is taken to be about 0·3, the maximum of the theoretical cross-section curve coincides with the experimental maximum if one assigns $1{\cdot}25\,\mu$ (μ = the reciprocal Compton wavelength of the meson) for the spin and isotopic spin inertia of the nucleon. The scattering cross-section curves for π^+ and π^- approximately agree with the experimental curves if one assigns a value 1·58 for $|G(K)|$, which appears in the original theory of Pauli. A.

530.145

630. Pseudoscalar mesons with applications to meson-nucleon scattering and photoproduction. S. D. DRELL AND E. M. HENLEY. *Phys. Rev.*, **88**, 1053–64 (*Dec.* 1, 1952).

The scattering of π^+ and π^- mesons by protons and the production of π^+ mesons by γ-rays incident on protons are studied with the quantized theory of pseudoscalar mesons with pseudoscalar coupling. The Dyson transformation is applied to the Hamiltonian to yield a new representation in which the velocity-independent aspects of the nucleon dynamics are more readily identified. A large "core" term appears in the meson-nucleon interaction in this representation and is incorporated into the zero-order Hamiltonian. The remaining interaction terms are treated perturbation-wise or according to the Heitler damping procedure. It is found that even after separating out the large core term, this method of approach fails to give agreement between theory and experiment. It does, however, improve on the results of the straight perturbation approximation and brings the theory in closer accord with the observations. It is suggested that a direct test of the role of the "core" term is possible in the process of double meson production by γ-rays incident on protons. A.

530.145

631. On the relation between the wave with singularity and the statistical wave in unitary relativistic theories. J.-P. VIGIER. *C.R. Acad. Sci.* [*Paris*] **235**, 869–71 (*Oct.* 20, 1952) *In French.*

De Broglie's ideas on the double solution in the pilot-wave theory allow the setting up of a relation analogous to that between wave fronts and Huyghen's wavelets in classical theory. R. H. DALITZ

530.145

632. Diffraction in time. M. MOSHINSKY. *Phys. Rev.*, **88**, 625–31 (*Nov.* 1, 1952).

In a previous note [Abstr. 773 (1952)] a dynamical description of resonance scattering was given, and transient terms appeared in the wave function describing the process. To understand the physical significance of these terms, the transient effects that appear when a shutter is opened are discussed in this paper. For a nonrelativistic beam of particles, the transient current has a close mathematical resemblance with the intensity of light in the Fresnel diffraction by a straight edge. This is the reason for calling the transient phenomena by the name of diffraction in time. The shutter problem is discussed for particles whose wave functions satisfy the Schrödinger equation, the ordinary wave equation, and the Klein–Gordon equation. Only for the Schrödinger time-dependent equation do the transient wave functions resemble the solutions that appear in Sommerfeld's theory of diffraction. The connection of transient phenomena with the time-energy uncertainty relation, and the interpretation of the transient current in a scattering process, are briefly discussed. The relativistic wave functions for the shutter problem may play an important role in the dynamical description of a relativistic scattering process. A.

530.145

633. Coulomb functions for heavy nuclear particles. W. D. Barfield and A. A. Broyles. *Phys. Rev.*, **88**, 892 (*Nov.* 15, 1952).

Values of the regular and irregular solutions and the derivative of the regular solution of the wave equation for repulsive Coulomb potential have been computed by contour integrals at the classical turning point. Results are given for the range $\eta = 10$ to $\eta = 200$, corresponding to the Coulomb interaction of heavy particles. A.

530.162

634. Characteristics of the fluctuations of the particle numbers in a system with Coulomb interaction. I. Z. Fisher. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 520–3 (1952) *In Russian.*

The fluctuations of the number of particles in a certain volume, and the correlation between the fluctuations in adjacent volumes cut out of a balanced electrically neutral system of charged particles, are estimated, The simplifying assumptions are that the numbers of oppositely charged particles are equal and that the diel. const. of the medium is 1. The problem is treated by a method suggested by N. N. Bogolyubov (*Problems of dynamical theory in statistical physics*, Moscow, 1946) and assumes binary ("radial") distribution functions of the system as given. If $R \gg D$, where R is the dimension of the domain considered and D is the Debye length, there is very strong correlation between the fluctuations of various kinds of particles, with the correlation factor = 1, the level of the quadratic fluctuations being half as great as that of fluctuations of non-interacting particles. However, if $R \ll D$, the charged particles fluctuate practically like non-interacting particles. These fluctuation characteristics lead to the interesting consequence that the total particle number fluctuates practically as in an ideal gas. This, however, does not apply to the first case ($R \gg D$), when the particle numbers fluctuate quite differently from the case of the ideal gas, independently of the degree of rarefaction of the system.

B. F. KRAUS

530.162

635. Heisenberg's uncertainty relation as a case of stochastic dependence. G. Herdan. Note in *Naturwissenschaften*, **39**, *No.* 15, 350 (1952).

It is noted that the formal identity of the generalized uncertainty relation for variables A, B with the product moment relation $|\overline{AB} - \bar{A}\bar{B}| \leqslant \sigma_A \sigma_B$ implies a statistical correlation between the variables A and B.

R. H. DALITZ

530.162 : 621.391

636. The concept of entropy in the calculation of probabilities. A. Fromageot. *Ann. Télécomm.*, **7**, 388–96 (*Sept.*, 1952) *In French.*

The concept of entropy has been introduced as a measure of the quantity of information. The principal circumstances in which entropy can be defined in connection with random functions are discussed. Instances of the use of this concept in the theory of communication are considered. W. T. BLACKBAND (R)

MECHANICAL MEASUREMENTS 531.7

531.715.1 : 535.417

Measurement of thickness of microscopic objects using three-beam interference. *See Abstr.* 779

531.717.1

637. Measurement of thicknesses of fine particles. W. H. M. Robins. Letter in *Nature* [*London*] **170**, 583 (*Oct.* 4, 1952).

An attachment, consisting mainly of a quartz spherical lens, to the sub-stage condenser of a Vickers projection microscope is briefly described with sketch. The lens makes contact with a microscope slide carrying a dispersion of fine particles mounted dry on its upper surface. On traversing the slide, particles are seen to meet the lens at distances, from the point of contact of lens and slide, which are proportional to the square roots of the thicknesses of the particles. Particles of 3–76 μ diameter can be measured. Transmitted light is used. The method is not easily adapted to the normal light microscope.

S. WEINTROUB

531.754 : 539.169

Density measurement of concrete slabs using gamma-rays. *See Abstr.* 1099

531.761 : 621.319.51 : 621.387 : 621.317.79

638. Electronic spark timing device. A. Bardócz and Á. Kemény. *Acta tech. Hungar.*, **3**, *No.* 3–4, 389–92 (1952). See Abstr. 5569 (1952).

MECHANICS OF FLUIDS 532

532.137

639. Theory of a rotation-vibration viscosimeter for highly viscous liquids. L. S. Priss. *Zh. tekh. Fiz.*, **22**, *No.* 6, 1050–61 (1952) *In Russian.*

The theory is further developed of the rotation-vibration viscosimeter suggested by Shvidkovskii for melted metals. It follows from the theory that the method can be used for liquids with a high kinematic viscosity, particularly for slags. Formulae and tables are given. The method has been verified on aqueous solutions of glycerol. F. LACHMAN

532.5

640. The essentials of fluid dynamics. L. Prandtl. *London and Glasgow, Blackie and Son* (1952) 452 *pp.*

A comprehensive survey of the whole field of fluid dynamics, including hydrostatics, perfect fluid flow, laminar and turbulent motion of viscous incompressible fluids, and compressible fluid flow. Physical arguments are used whenever possible in presenting the theory, and complicated mathematical analysis is avoided. Experimental results are described with many photographs and diagrams, and applications to hydraulics, aeronautics and meteorology are included. References to original papers throughout. Bibliography. J. G. OLDROYD

532.517

641. A uniqueness theorem for flow of a heavy perfect fluid. R. Gerber. *C.R. Acad. Sci.* [*Paris*] **235**, 693–4 (*Oct.* 6, 1952) *In French.*

A set of sufficient conditions is obtained for

uniqueness of the solution of the problem discussed in Abstr. 1507 (1952). J. G. OLDROYD

532.525

642. Some viscous fluid flow problems. I. Jet emerging from a hole in a plane wall. H. B. SQUIRE. *Phil. Mag.*, **43**, 942–5 (*Sept.*, 1952).

An exact solution of the equations of viscous fluid flow for axially-symmetric motion is studied for a special case: this is shown to give the flow for a jet emerging from a hole in an infinite plane wall. Some examples of the calculated streamlines are given. A.

532.525

643. Fast jets from collapsing cylinders. W. S. KOSKI, F. A. LUCY, R. G. SHREFFLER AND F. J. WILLIG. *J. appl. Phys.*, **23**, 1300–5 (*Dec.*, 1952).

A method is described for producing fast jets from the collapse of metal-lined cavities in high explosives. The behaviour of these jets suggests that they cannot be accounted for by the simple hydrodynamical considerations that have in the past been successful when applied to slower type jets. Various experiments, including time-resolved spectrographic observations, show the jets to be, at least in part, of a gaseous nature. Velocities as high as 90 km/sec have been observed for Be jets, with heavier elements exhibiting lower velocities in inverse order of their atomic weights. A.

532.525 : 778.5 : 778.37

The development of a multi-flash camera and its application to the study of liquid jets. *See Abstr.* 1325

532.525/.527

644. Axially symmetrical jet mixing of a compressible fluid. S. I. PAI. *Quart. appl. Math.*, **10**, 141–8 (*July*, 1952).

The literature of laminar and turbulent jet-mixing is briefly reviewed, and the analysis used by the author to discuss the laminar and turbulent flow of a two-dimensional jet, from a finite orifice, of compressible fluid exhausting into a uniform stream, and the mixing of two streams of compressible fluid, is now extended to discuss the laminar and turbulent flow of an axially-symmetrical jet of compressible fluid into a uniform stream. For the case of laminar flow, a solution by the method of small perturbations is first obtained, and a numerical integration method is used to compute the temperature and velocity distributions in the exact solution. For the case of turbulent flow in the jet, the fundamental equation of motion of an axially symmetrical jet is derived by using Taylor's hypothesis relating to the transport of vorticity and Reichardt's assumption of free turbulence, i.e. the assumption that the exchange coefficient over each cross-section of the mixing zone is constant. By suitable transformation of the variables, the equations of turbulent flow become identical with those of laminar flow, and the solution for the case of laminar flow can be used for the case of turbulent flow, provided the empirical value of the eddy viscosity is evaluated experimentally. J. S. G. THOMAS

532.527

645. The theory of turbulence relating to a moving profile in the non-stationary régime. J.-J. MOREAU. *C.R. Acad. Sci.* [*Paris*] **235**, 695–7 (*Oct.* 6, 1952) *In French.*

In his linearized theory of the thin profile in the non-stationary regime, Birnbaum and his followers have introduced the notion of an equivalent turbulent curvilinear distribution, in which the turbulent loads are divided into two types, viz. bound vortices, attached to the profiles, and free vortices carried by the fluid. The expressions derived by means of the linearized theory for the calculation of stresses upon the profile are equivalent to a local application of Joukowsky's rule to bound vortices. This result is now shown to be rigorous and general in the case of a perfect incompressible fluid, even in the absence of a velocity potential. The arbitrary character of the dissociation of the layer of slip into turbulences of two kinds is revealed, and a simpler, natural viewpoint is discussed. J. S. G. THOMAS

532.527

646. Aspects of the turbulence problem. H. W. LIEPMANN. *Z. angew. Math. Phys.*, **3**, *No.* 5, 321–42 (1952).

Some general aspects of the turbulence problem, more especially those which are often omitted in reviews of the subject, are briefly discussed; important results of isotropic turbulence research are briefly summarized, while stability theory and transition from stability to instability are omitted from the review. General characteristic features of turbulent shear flow are stressed. Sections are devoted to (1) stationary stochastic processes; (2) the response of linear systems to random forcing functions, including turbulence; (3) the general problem of turbulent transfer and the concepts of local isotropy and intermittency, and (4) a review of isotropic, homogeneous turbulence. A bibliography comprising 33 references is appended. J. S. G. THOMAS

532.528

647. Vertical entry of missiles into water. A. MAY. *J. appl. Phys.*, **23**, 1362–72 (*Dec.*, 1952).

Investigations, carried out principally on the vertical water entry of steel spheres, are described. Graphs show the effect of several experimental parameters on the time and place of occurrence of various events in the life of the cavity which accompanies the entry. These parameters include the density and pressure of the atmosphere above the water, and the velocity, size and nose shape of the missile. Froude-scaling is found to be a good first approximation in describing cavity behaviour, and some improvement is effected by the pressure-density scaling of the atmosphere above the water. The energy lost by a missile during the open-cavity phase of its water entry is found to be used up principally in the formation of the cavity, and the cavity shape is not dependent on the nose shape of the missile for a given drag force. A.

532.570.8

648. Rheoelectric study of infiltration problems. P. H. DE LA MARRE. *C.R. Acad. Sci.* [*Paris*] **235**, 602–3 (*Sept.* 22, 1952) *In French.*

A paper instrument and method described by Malavard (1951) is found to be very suitable for the experimental determination of flow through porous masses. It has been verified for the case of vertical dam walls, and the accuracy is 1–4% for rate and 1–2% for length of flow. An illustration is included of the possibilities of the apparatus. H. H. HODGSON

532.58

649. On the squirming motion of nearly spherical deformable bodies through liquids at very small Reynolds numbers. M. J. LIGHTHILL. *Commun. pure appl. Math.*, **5**, 109–18 (*May*, 1952).

A spherical deformable body can swim, at very small Reynolds numbers, by performing small oscillations of shape. However, the mean velocity of translation is at most of the order of the square of the amplitude of the deformations. Three examples of swimming motions, in each of which the maximum surface strain is 1/3, are illustrated. Even in the most efficient of the three, the mean power required to obtain a given mean velocity is twenty times that given by Stokes' formula for the uniform motion of a rigid sphere under an external force. This ratio varies as the inverse square of the maximum surface strain. A.

532.58

650. The moment of a submerged solid of revolution moving horizontally. T. H. HAVELOCK. *Quart. J. Mech. appl. Math.*, **4**, 129–36 (*June*, 1952).

A prolate spheroid moves axially with uniform velocity, with its axis at a constant depth below the surface of water on which surface waves are generated. If the motion in an infinite liquid can be represented by a known source-sink distribution along the axis, then the horizontal and vertical forces on the solid, due to the wave motion, can be obtained by the usual approximation. To determine the moment, G, about a transverse horizontal axis, however, it is necessary to obtain the velocity potential, ϕ, to a higher degree of approximation. This extension is now carried out to a third approximation, and the form of the additional term in the moment suggests an approximation applicable to other elongated solids of revolution, e.g. a Rankine ovoid, generated by an axial source distribution. Numerical values of G have been calculated for a spheroid of length-beam ratio 10·5 at two depths of immersion. G at low speeds may be positive or negative and small; after a Froude number > about 0·4, G remains negative and increases rapidly towards its limiting value. The negative value of the moment at high speeds, which seems unexpected, compared with the case of surface ships, is explained by the fact that the submerged spheroid is roughly in a stream whose effective direction in its vicinity is inclined to the horizontal axis of the spheroid, thus providing a moment tending to increase this angle, i.e. a negative moment.

J. S. G. THOMAS

532.582.2

651. Impulsive motion of an infinite plate in a viscous compressible fluid. M. D. VAN DYKE. *Z. angew. Math. Phys.*, **3**, *No.* 5, 343–53 (1952).

The introduction of compressibility greatly complicates the comparatively simple problem of determining the fluid motion due to an infinite flat plate, impulsively started moving in its own plane with uniform velocity, U. Methods of attacking the problem, including that involving the boundary layer approximation, used by Illingworth [Abstr. 131 (1951)] and by Stewartson [Abstr. 9306 (1951)] are very briefly reviewed, and this method of solution is systematically improved. The procedure involves alternately iterating upon the boundary layer solution in the boundary layer, and upon the acoustic solution in the outer flow field. The two solutions are matched at the outer edge of the boundary layer by comparing their asymptotic expansions. It is assumed that the value of the Prandtl number is 1, that the variation of viscosity with enthalpy is linear, and that the plate is insulated. The results complement Howarth's solution [Abstr. 9305 (1951)] and agree with it in the region of common validity. The third approximation is carried out in detail. Interaction between the boundary layer and the outer flow field reduces the skin friction. The boundary layer approximation is permissible only if the max. normal velocity is small, compared with U, which requires that $M^2 \ll R^{1/2}$, M denoting the Mach number, and R the Reynolds number of the fluid motion. Acoustic theory is applicable to the outer flow only if the normal velocity at the edge of the boundary layer is small compared with the speed of sound, which requires $M^3 \ll R^{1/2}$.

J. S. G. THOMAS

532.584 : 530.162

652. On the theory of the Brownian deformation. R. CERF. *C.R. Acad. Sci.* [*Paris*] **235**, 876–8 (*Oct.* 20, 1952) *In French.*

A study of the influence of thermal agitation on the properties of a suspension of elastic spheres under a hydrodynamic field.

T. C. TOYE

CAPILLARITY 532.6

532.69 : 532.73

653. Miscibility of liquids influenced by rate of shear. A. SILBERBERG AND W. KUHN. *Nature* [*London*] **170**, 450–1 (*Sept.* 13, 1952).

Outlines an investigation on the behaviour of a solution of two polymers (polystyrene and ethyl cellulose, totalling 2–3%) in C_6H_6 when temperature and the field of flow are changed. The critical solution temperature (the temperature above which the solution remains homogeneous and below which it separates into two phases, each containing predominantly one of the two solutes) decreases as the rate of shear (velocity gradient) q increases, the relationship being $q = 20\Delta T$. The changes observed are completely reversible. While the equation $r = \text{const}(\sigma/\eta q)$, where r is the radius of droplets generated by stirring, σ—the interfacial tension, and η—the viscosity of the surrounding medium, represents the effect of the field of flow at low rates of shear and up to drop sizes of $c.\ 10^{-3}$ cm, it has been found that the further decrease in the drop size causes a rapid decrease of interfacial tension and the reversal of the phase separation. The breakdown of σ occurs between $r = 10^{-2}$ and 10^{-3} cm. A simplified thermodynamical explanation of this phenomenon is given. The otherwise unstable homogeneous state is maintained during stirring at the expense of the continuous degradation of mechanical into thermal energy in the field of flow. It is suggested that the effects observed (shift in solubility and critical solution temperature) are not specific to systems with macromolecular components.

F. LACHMAN

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

654. On the statistical theory of concentrated solutions of strong electrolytes. I. A. E. GLAUBERMAN AND I. P. YUKHNOVSKIĬ. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 562–71 (1952) *In Russian.*

Inclusion of the dielectric constant of the solvent in the law of interaction takes account of the solvent. Mathematical difficulties are removed by including the interaction potential, which accounts for repulsive forces quantitatively but does not contain the Coulomb term for small interionic distances. A general formula for binary distributions is found, and for the zero approximation the dependence on concentration is discussed. J. JACOBS

532.7

655. On the statistical theory of concentrated solutions of strong electrolytes. II. A. E. GLAUBERMAN AND I. P. YUKHNOVSKIĬ. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 572–8 (1952) *In Russian.*

On the basis of Pt I a formula is derived which for very weak concentrations goes over into the Debye law. Comparison with experimental data shows good results up to 0·5–0·6 mol/l concentrations. J. JACOBS

532.72

656. Diffusion of acetone into polyvinyl acetate above and below the second-order transition. R. J. KOKES, F. A. LONG AND J. L. HOARD. *J. chem. Phys.*, **20**, 1711–16 (*Nov.*, 1952).

The sorption kinetics for the system polyvinyl-acetate acetone have been investigated both above and below 30°C, the second-order transition temperature for the pure polymer. At 30, 40 and 50°C, the diffusion obeys Fick's law with a concentration-dependent diffusion coefficient. With increasing acetone concentration the value of the diffusion coefficient increases strongly, and the energy of activation for diffusion decreases. At each temperature below 30°C, diffusion is Fickian only for sorption and desorption experiments where the solvent concentration is above a certain critical value. It was found, by comparison with the results of volume-temperature measurements on the system polyvinyl acetate-acetonyl acetone, that the temperature corresponding to a given critical concentration is the second-order transition temperature for this polymer-solvent mixture. Evidently, the changes which occur at the second-order transition have a pronounced influence on the diffusion process. A.

532.787

657. Thin films of supersaturated solutions for detecting, counting and identifying very small crystalline particles. B. VONNEGUT. *Science*, **116**, 300–1 (*Sept.* 19, 1952).

Films of solution supersaturated with respect to a given crystalline substance are prepared by mixing an unsaturated solution of the substance in a volatile solvent with various amounts of a non-volatile solvent until the latter becomes supersaturated when the volatile solvent evaporates. The film of supersaturated solution can be used for detecting and counting very small crystalline particles of the dissolved substance or other substances which will cause the solution to crystallize. A. J. MEE

MECHANICS OF GASES 533

533.15 : 533.7

658. Intermolecular force and coefficient of self-diffusion. B. N. SRIVASTAVA AND M. P. MADAN. *Phil. Mag.*, **43**, 968–75 (*Sept.*, 1942).

The Chapman–Enskog theory of non-uniform gases, as applied to the phenomenon of self-diffusion, has been utilized to evaluate the intermolecular force constants. The collision integrals occurring in the Chapman–Enskog formula for self-diffusion, as evaluated by Hirschfelder, Bird and Spotz by assuming the 12 : 6 power form of the Lennard–Jones potential function, have been used. The temperature variation of self-diffusion has been utilized to obtain the constant ε of the Lennard–Jones function, which represents the maximum negative energy of interaction of two molecules. The intermolecular separation r_0 for zero interaction energy occurring in the same potential function has been calculated by actual substitution. The recent data on self-diffusion as reported by Winn, Winter and others have been used to obtain these constants and the values compared with those given by Hirschfelder *et al.* from viscosity and virial coefficient data. A.

533.6.011

659. A selection of tables for use in calculations of compressible airflow. *Oxford, Clarendon Press* (1952) 143 *pp.*

Selected tables are presented of widely used formulae and functions of established fundamental importance. They are grouped under the headings: (i) isentropic flow, (ii) characteristics, (iii) shocks, (iv) reduction of pressure ratios, (v) powers of x and $(1 - x^2)$, and (vi) miscellaneous, and are followed by a list of useful functions of γ (assumed throughout to be equal to 1·4). The value adopted for viscosity of dry air at 23°C is 183·00 ± 0·25 micropoise. The companion volume of graphs is to be published soon. A. GELBTUCH

533.6.011.4

660. Study of the curvature at the tip of an attached shock wave in non-stationary plane flow. H. CABANNES. *C.R. Acad. Sci.* [*Paris*] **235**, 698–700 (*Oct.* 6, 1952) *In French.*

The shock wave attached to the tip of an obstacle placed in an uniform supersonic stream, and rotating about the tip, is discussed mathematically, and it is shown that by varying the angular velocity of the obstacle, it is possible to obtain any value whatsoever, positive or negative, for the curvature (ρ) of the shock wave at the tip. For two positions of the obstacle, ρ becomes infinite. J. S. G. THOMAS

533.6.011.5

661. The flow pattern of a supersonic projectile. G. B. WHITHAM. *Commun. pure appl. Math.*, **5**, 301–48 (*Aug.*, 1952).

A complete first approximation is given of the

supersonic flow of fluid past any slender axi-symmetrical body-wake combination, the meridian section of which may have discontinuities in slope. The amply-substantiated assumption is made that the failures of linearized theory to describe the flow pattern may be corrected by replacing the approximate characteristics used in that theory by the exact characteristics, or, at least, by a sufficiently good approximation to the exact ones. To complete the description of the flow, the shocks, which occur in regions where the characteristics would otherwise form a limit line and the solution ceases to be single-valued, are determined from the geometrical property that, to a first order, a shock bisects the angle between the characteristics on each side of it. This affords a simple qualitative picture of how the shocks occur and fit into the pattern. The general theory is applied to discuss the case of a 5–10 calibre ogival-headed bullet with a suitable wake. Pressure at any point in the fluid is determined, and the manner in which drag is related to the rate of increase of the energy of the fluid is studied. A new expression is derived for the von Kármán drag in terms of a function which is fundamental to the whole theory. An appendix, devoted to the corresponding theory for the two-dimensional steady and one-dimensional unsteady flows, contains some new information on these topics, including the case of a piston oscillating periodically. At a large distance from the piston, the strengths of the shocks depend only on the properties of the fluid, the distance from the piston and the period of the oscillation; they are independent of the particular piston motion. J. S. G. THOMAS

533.6.07

662. New idea relating to the design of supersonic tuyères for blowers. P. CARRIÈRE. *C.R. Acad. Sci.* [*Paris*] **235,** 697–8 (*Oct.* 6, 1952) *In French.*

It is suggested that tuyères for blowing-plants should be designed so that the uniform Mach number (M) desired for the flow is attained only in the central part of the flow, while velocities at the periphery of the flow have lower values than that corresponding to M. Thereby, it is considered that the performance of existing installations can be considerably improved, and practical problems relating to supersonic blowers more easily solved. A design of truncated tuyère, incorporating the idea, is illustrated, and two possible applications are very briefly discussed. J. S. G. THOMAS

533.6.07

663. A new method of determining the aerodynamic characteristics of projectiles in a wind tunnel. A. AURIOL. *C.R. Acad. Sci.* [*Paris*] **235,** 701–2 (*Oct.* 6, 1952) *In French.*

A model projectile is launched with a velocity of a few metres/sec in a tunnel in the opposite direction to that of the airflow, and its drag and stability are deduced from its motion. Thus, e.g. the model may be launched upwards in a vertical tunnel in which the air stream flows downwards; the velocity of the projectile is progressively reduced, reduced to zero and reversed. The method avoids errors due to the use of devices supporting the projectile, is simple and cheap and can be operated with very high Mach numbers. Preliminary experimental results are illustrated. J. S. G. THOMAS

MOLECULAR THEORY OF GASES 533.7

533.75

664. Low temperature second virial coefficients for a 6–9 potential. G. M. ROE, L. F. EPSTEIN AND M. D. POWERS. *J. chem. Phys.*, **20,** 1665–9 (*Nov.*, 1952).

Alternate expressions for the second virial coefficient of a gas having a Lennard–Jones 6–9 potential are derived to cover the temperature range where the known power series expansion in $\theta = \varepsilon/kT$ is inconvenient for numerical computations. For $\theta \geqslant 2$ the second virial coefficient can be expressed as a combination of Bessel functions of imaginary argument plus a small correction term. This formulation and an asymptotic expression derived from it are used to tabulate numerical values of the second virial coefficient in the range $2 \leqslant \theta \leqslant 100$. A.

533.75

665. Low temperature second virial coefficients for a Lennard–Jones gas. L. F. EPSTEIN. *J. chem. Phys.*, **20,** 1670–2 (*Nov.*, 1952).

For low temperatures, the second virial coefficient $B(\theta) = \frac{2}{3}\pi N r_0^3 G(\theta)$, of a gas which follows a Lennard–Jones $6 - s$ potential, $U_s(r) = \{\varepsilon/(s-6)\}[6(r_0/r)^s - s(r_0/r)^6]$, where $\theta = \varepsilon/kT$, can be represented by $G_s(x) \sim -e^{+\theta}(3\pi/s\theta)^{\frac{1}{2}} \sum_{n=0} \beta_n(s)/\theta^n$. In two previous studies [Abstr. 6339 (1952) and preceding abstract] formulae for $\beta_n(9)$ and $\beta_n(12)$ have been presented. In this paper, the relation for $G_s(\theta)$ is developed for the general case, using the method of steepest descents, and the first three coefficients $\beta_0(s)$, $\beta_1(s)$ and $\beta_2(s)$ are computed. The use of a Hooke's law potential and the quasi-ideal gas hypothesis yields the correct leading term in $G_s(\theta)$, but results in errors in $\beta_1(s)$ and $\beta_2(s)$. A.

VIBRATIONS . ACOUSTICS 534

534

666. An introduction to acoustics. R. H. RANDALL. *Cambridge, Mass.: Addison-Wesley Press,* xii + 340 *pp.* Review in *Brit. J. appl. Phys.*, **3,** 365 (*Nov.*, 1952).

534.113

667. Analytical and numerical complements to the study of vibrating rods. II. D. CALIGO. *R.C. Accad. Naz. Lincei,* **12,** 277–84 (*March,* 1952) *In Italian.*

For Pt I, see Abstr. 4183 (1952). Eigenvalues and eigenfunctions are worked out for a homogeneous rod fixed at one end and free at the other. L. PINCHERLE

534.113

668. Effect of variation in diameter on the torsional vibration of bars. H. PURSEY. Letter in *Nature* [*London*] **170,** 502 (*Sept.* 20, 1952).

A bar of non-uniform diameter has resonant frequencies which do not form a harmonic series.

Using a Fourier expansion for the variation in diameter as a function of axial distance, the frequencies are calculated and found to be in good agreement with those observed. J. G. OLDROYD

534.121

669. Axially symmetric vibrations of a finite isotropic disk. II. R. R. AGGARWAL. *J. Acoust. Soc. Amer.*, **24**, 663–6 (*Nov.*, 1952).

For Pt I, see Abstr. 8737 (1952). The calculations presented in Pt I have been extended so as to include vibrations, which are antisymmetric with respect to the central plane of the disk. Curves showing the normal components of the displacements at the boundary surfaces are also drawn, to get the vibration patterns according to the theoretical assumptions made. A.

534.13 : 532.65

670. Vibrations of evaporating liquid drops. N. J. HOLTER AND W. R. GLASSCOCK. *J. Acoust. Soc. Amer.*, **24**, 682–6 (*Nov.*, 1952).

An unusual type of vibration of flattened spheroidal liquid drops, occurring under certain conditions, is described and illustrated. Appropriate liquids placed on a sufficiently hot horizontal surface float on a film of their own vapour, which vapour insulates the drop so that it evaporates quite slowly, this phenomenon being known as the Leidenfrost effect. It is under these conditions that drops have been found capable of sustaining large amplitude regular radial vibrations whose driving force is probably related to the radial flow of vapour below the drops. The vibrating drops are approximately polygons which may have any of 2, 3, 4, . . . n sides, seen by the eye as drops with 4, 6, 8 . . . $(2n + 2)$ regular lobes around the circumference. Methods of exciting and recording the effect are described. A.

534.132

671. An investigation of sound vibrations in a tube containing a heat source. J. L. NEURINGER AND G. E. HUDSON. *J. Acoust. Soc. Amer.*, **24**, 667–74 (*Nov.*, 1952).

The aerothermodynamic process inside a tube in which is placed a heat source and through which air is flowing is investigated theoretically. The formulation is based partly on the assumption that the average state of the medium inside may be approximated by a step distribution in the gas variables, a simplifying hypothesis suggested by experimental observations by Lehmann. The zeroth-order (mean hydrodynamic flow) and first-order (acoustic) solutions inside the tube are first obtained using a heat transfer law for the heater which depends on some arbitrary function of the local values of the gas variables, velocity-gradient and source temperature. Upon the basis of a few hypotheses regarding turbulent flow and turbulent heat transfer, the possible existence of heaters whose heat transfer rate depends essentially on the negative of the velocity gradient of the flow through them is demonstrated. The solution is then specialized to those types of heaters, and it is shown that, in agreement with the so-called Rijke effect, growth of the fundamental tone may occur with the heater almost anywhere in the first half of the tube from the blower end to the node, with decay almost everywhere else. The exact positions of the regions of growth and decay of sound inside the tube are then investigated. A.

534.132

672. Dependence of *Pfeifenton* (pipe tone) frequency on pipe length, orifice diameter, and gas discharge pressure. A. B. C. ANDERSON. *J Acoust. Soc. Amer.*, **24**, 675–81 (*Nov.*, 1952).

Measured dependences of the *Pfeifenton* frequency on static flow pressure, orifice diameter and pipe length are presented, based upon studies of air flowing through pipes terminated in various orifices. Frequency measurements were made of the vibrations inside the pipe. The *Pfeifentöne* are not a series of discrete single-valued harmonics. Each covers a range of frequencies, any specific value of which is determined by the discharge flow-velocity or pressure. When the orifice diameter approaches zero the behaviour of the primary *Pfeifenton* frequencies is as if they were produced by an open-closed organ pipe; when the orifice diameter approaches that of the pipe, the behaviour is as if they were produced by an open-open organ pipe. A mechanism for the excitation of the *Pfeifentöne* is proposed. A.

534.132 : 532.51

673. Periodic fluid flow through circular tubes. G. B. THURSTON. *J. Acoust. Soc. Amer.*, **24**, 653–6 (*Nov.*, 1952).

Some aspects of the periodic flow of an incompressible fluid through a circular tube of large length to diameter ratio have been studied. Expressions for the analogous acoustic resistance and inductance of the tube are presented. An experimental investigation of the resistance and inductance is described in which the tube dimensions, the viscosity of the fluid, and the frequency of the periodic motion are varied over a wide range. The experimental results are found to be in good agreement with the predictions of the hydrodynamical theory. A.

534.22/.23

674. Acoustic propagation in granular media. R. W. MORSE. *J. Acoust. Soc. Amer.*, **24**, 696–700 (*Nov.*, 1952).

A theory is developed for the sound velocity and attenuation in a medium composed of closely packed solid particles immersed in a fluid. The absorption mechanism considered is that of viscous motion of fluid between the particles, and the macroscopic point of view is taken. For high enough frequencies the attenuation is proportional to the square root of the product of frequency and static flow resistance of the medium. Comparisons are made with data reported previously by others, and the agreement with the theoretical results is good for cases involving particles of nearly uniform size. Still another frequency effect, dependent on the size distribution, is evident for unsorted granular substance. A.

534.22/.23 : 533.7 : 536.7

675. Dispersion and absorption of sound in mixtures of gases. D. TABUCHI. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 65–73 (1952).

A calculation of the complex velocity of sound for gas mixtures containing molecules with an arbitrary number of vibrational levels and modes of vibration. Absorption due to viscosity and heat conduction is neglected, and it is assumed that there is no dispersion and absorption due to transitions between rotational quantum states. The results, it is claimed, are

obtained in a simple form convenient for comparison with experiment. E. H. SONDHEIMER

534.22

676. Ultrasonic propagation in xenon in the region of its critical temperature. A. G. CHYNOWETH AND W. G. SCHNEIDER. *J. chem. Phys.*, **20**, 1777–83 (*Nov.*, 1952).

Only the limited frequency range from 250 kc/s to 1250 kc/s could be used close to the critical temperature and over this interval a velocity dispersion of as much as 6% was observed. The dispersion was accompanied by an abnormally high attenuation of the sound wave confirming in this respect the previously observed behaviour of other systems near their critical point. From an analysis of the dispersion measurements it is concluded that structural relaxation processes play a dominant role in the mechanical behaviour of the system. The results also indicated the presence of a very wide spectrum of relaxation times. A.

534.22

677. Translational dispersion in monatomic gases. R. A. BOYER. *J. Acoust. Soc. Amer.*, **24**, 716–17 (*Nov.*, 1952).

A comparison is made between the results of experiment and theoretical predictions of translational dispersion in the monatomic gases A and He. Second-order approximations to the dispersion are presented for the continuum theory, treating the Stokes–Navier equations as exact, and for deductions from kinetic theory, assuming that the molecules behave as (1) elastic spheres, (2) Maxwellian molecules, and (3) molecules obeying a Lennard–Jones type potential. Agreement between experiment and kinetic theory predictions is rather favourable in the range compared, which is at 0°c, approximately 970 kc/s, and down to about 2 mm Hg pressure. The increases in velocity of propagation (at the lowest pressures) over that at standard conditions are 27% for A and 0·6% for He. A.

534.222.2

678. Initial behaviour of a spherical blast. J. A. MCFADDEN. *J. appl. Phys.*, **23**, 1269–75 (*Nov.*, 1952).

At time $t = 0$ a unit sphere containing a perfect gas at uniformly high pressure is allowed to expand suddenly into a homogeneous atmosphere. Solutions for short times later are sought by analytic (i.e. not numerical) methods. Viscosity and heat conduction are neglected. The particle velocity, sound speed and entropy are developed in powers of y, which is proportional to the time (more precisely, the distance moved by the head of the rarefaction wave in time t), with coefficients depending on a slope co-ordinate $q = (1/2N)[(2N - 1) + (1 - x)/y]$, where x is the radial co-ordinate, $N = (\frac{1}{2})(\gamma + 1)/(\gamma - 1)$, and γ is the ratio of specific heats. The zero-order coefficients are the plane shock-tube solution. First-order corrections are derived for the various regions. Boundary conditions are approximated for small y at the surfaces of discontinuity, and the method for matching the solutions in the different regions is outlined. This matching process is carried out for the expansion of a diatomic gas into diatomic air. A.

534.222.2

679. The profile of a steady plane shock wave. H. GRAD. *Commun. pure appl. Math.*, **5**, 257–300 (*Aug.*, 1952).

Theoretical. A theory of shock wave structure is presented, in which the effects of viscosity and thermal conduction are approached from the kinetic-theory standpoint, using an approximation to the Boltzmann equation (the "13-moment" approximation) developed by the author [Abstr. 5600 (1950)]. It is found that a solution exists only below Mach No. $M = 1{\cdot}65$; this solution differs from the usual Navier–Stokes solution above $M = 1{\cdot}2$, and it is concluded that the Navier–Stokes solution is inapplicable above $M = 1{\cdot}2$. In terms of dimensionless variables based on the choice as a reference length of the mean free path at a point within the shock, the shock profile approaches a limiting value for both strong and weak shocks; the limiting profile for weak shocks is the same for all variables, and for all types of dependence of viscosity and thermal conductivity upon temperature. The shock thickness as a function of shock strength is bounded, and is greater (by 2% at $M = 1{\cdot}18$ and by 15% at $M = 1{\cdot}61$) than would be predicted on the basis of the Navier–Stokes solution. This is in qualitative agreement with somewhat inaccurate exptl. measurements of the thickness of shock waves in argon [Abstr. 8570 (1950)].

A. SCHOFIELD

534.222.2

680. The interaction of plane shock waves and rough surfaces. R. E. DUFF. *J. appl. Phys.*, **23**, 1373–9 (*Dec.*, 1952).

Shock tube experiments have been conducted to determine the effect of surface roughness on shock waves in N passing over the surface. Shock retardation was measured for a series of two- and three-dimensionally rough surfaces at shock strengths from $\xi = 0{\cdot}1$ to $\xi = 0{\cdot}9$. The first-order approximation was made that the volume between the positions of the shock wave, with and without the rough surface present, multiplied by the specific energy behind the undisturbed shock wave represented energy dissipated by the roughness. The space rate of energy dissipation is presented as a function of the average particle size of the rough surface. It is also shown that the curvature of the shock wave in the vicinity of the surface depends on the roughness of the surface, the length of roughness covered, and the strength of the shock wave. In addition, the hundreds of measurements of shock wave contours made in this investigation showed that there is a random fluctuation in the angle of incidence of the primary shock wave of 1/15°. This fluctuation is presumably caused by the details of the diaphragm rupture even though measurements were made 14 ft from the diaphragm in a shock tube with a 2×7 in cross-section. A.

534.222.2

681. The production of high temperature gases in shock tubes. E. L. RESLER, S.-C. LIN AND A. KANTROWITZ. *J. appl. Phys.*, **23**, 1390–9 (*Dec.*, 1952).

Aims at setting forth aerodynamic and thermodynamic calculations which are useful in the production of strong shock waves. The experimental

production of strong shock waves is discussed. Comparison of the experimental shock strengths with the theoretical calculations is made, and finally, some preliminary results of shock tube studies in high temperature gases (up to 18 000°K) are briefly surveyed. A.

534.23

682. Acoustic relaxation in a van der Waals gas. R. T. BEYER. *J. Acoust. Soc. Amer.*, **24**, 714–15 (*Nov.*, 1952).

Expressions are given for the sound velocity and the absorption coefficient per unit wavelength for a van der Waals gas. Numerical calculations have been carried out for several triatomic gases. In general, the velocity corrections, under standard conditions, average about 0·5%, while the absorption corrections are two or three times larger. A.

534.23

683. Attenuation of sound resulting from ionic relaxation. L. H. HALL. *J. Acoust. Soc. Amer.*, **24**, 704–8 (*Nov.*, 1952).

Slowness in the rearrangement of ion configuration under acoustic perturbation should cause sound absorption in ionic solutions. This mechanism is investigated from the standpoint of the Debye–Hückel theory of strong electrolytes. The electrostatic part of the free energy of the solution is formulated in terms of temperature, volume and an ion configuration function. The partial derivative of this expression with respect to volume gives the electrostatic component of pressure. A rate equation for change of ion concentration at a point enables the variation in the ion configuration function with a small harmonic fluctuation in volume to be found. Since the pressure is expressed in terms of the configuration function, this leads readily to the relaxational bulk modulus connected with rearrangement. The rate equation involves a parameter which in interionic theory has been identified as the relaxation time of the ionic atmospheres and can be evaluated from conductivity data. A calculation made for $MgSO_4$ solutions sets the relaxation frequencies for 0·001 and 0·01 molal concentrations at 21 and 143 Mc/s, respectively, and shows the maxima in the wavelength absorption coefficients to be 20 and 660×10^{-9} respectively. The recently reported much higher excess absorptions for $MgSO_4$ at lower frequencies are thus due to processes other than ionic relaxation. A.

534.24

684. The reflection of a transient pulse by a parabolic cylinder and a paraboloid of revolution. W. CHESTER. *Quart. J. Mech. appl. Math.*, **5**, 196–205 (*June*, 1952).

A direct comparison is made between the reflection of a sound-pulse obtained with a body of revolution and the corresponding cylinder. The theoretical treatment yields general information as to the relation between the diffraction effects induced by two-dimensional and axially symmetric barriers. At the common junction of the incident wave front, the reflected front and the barrier, the pulse discontinuity reproduces the familiar doubling of pressure obtained in regular reflection. In other directions the discontinuity tends to zero inversely as the square root of the distance from the focus in the case of the parabolic cylinder, and inversely as the distance for the paraboloid of revolution. The excess pressure distribution along the boundary is calculated when the incident pulse is a simple step function.

A. B. WOOD

534.24

685. Remarque on critical reflections of elastic waves at free surfaces. W. S. JARDETZKY. Letter in *J. appl. Phys.*, **23**, 1279–80 (*Nov.*, 1952).

Shows that Goudier and Bishop's result [Abstr. 2537 (1952)] can be obtained from the known solution of the wave equation, thus avoiding the limiting process. J. E. CAFFYN

534.24

686. Comments on "Remarque on critical reflections of elastic waves at free surfaces." J. N. GOODIER. Letter in *J. appl. Phys.*, **23**, 1280 (*Nov.*, 1952).

See preceding abstract. Replies that the known solution assumes the limiting process. J. E. CAFFYN

534.24

687. Elastic wave propagation in solid media. R. A. MAPLETON. *J. appl. Phys.*, **23**, 1346–54 (*Dec.*, 1952).

The reflection of elastic waves at plane solid-vacuum interfaces and the two-dimensional solutions of the vector equation of equilibrium for elastic waves propagating through elastic plates of uniform thickness are investigated. Both the isotropic solid and the cubic system of nonpiezoelectric single crystals are treated. The objective is to compare multiple reflection solid delay lines, isotropic *v.* single crystal, in terms of the thickness of the plate required for satisfactory propagation and reflection characteristics. The sections on wave propagation are not exhaustive, but consider the particular wave mode that most closely resembles the plane shear wave with displacement component normal to the faces of the plate. In the sections on single crystals, it is shown that plane shear waves propagate with a speed independent of the direction provided that the displacement is parallel to a crystallographic axis. The reflection laws for these plane shear waves are the same for isotropic solids and single crystals provided that the displacement is contained in a plane that is parallel to the stress-free interface. A calculation compares the wave propagating characteristics of plates of fused quartz and calcium fluoride for operation at 15 Mc/s. The plate of calcium fluoride should be roughly three times thicker to give the same performance as the plate of fused quartz. A.

534.24

688. Reflection of sound wave due to a hollow cylinder in an elastic body. K. KATO. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 16–20 (1952).

It is shown that the intensity of the reflected wave due to a hollow cylinder in an elastic body is comparable with that due to a rigid cylinder in a liquid or in air. The calculations are made in connection with ultrasonic flaw-detectors. It is pointed out that owing to the generation of a shear wave when the incident wave strikes the cylinder, it is possible to obtain a ghost-image on the oscilloscope of the detector. G. F. HODSMAN

534.25

689. The effectiveness of plastic focusing lenses with high intensity ultrasonic radiation. J. A. Bronzo and J. M. Anderson. *J. Acoust. Soc. Amer.*, **24**, 718–20 (*Nov.*, 1952).

An investigation of the behaviour of Plexiglas and polystyrene lenses as focusing devices for ultrasonic radiation is described. A fixed frequency of 1 Mc/s and intensities up to 6·6 W/cm² were employed. Using a thermocouple probe to obtain records of intensity of radiation in a water tank, it was found that above about 2 W/cm² the Plexiglas showed signs of physical breakdown. Up to the maximum intensities employed, polystyrene showed no indication of damage, while at 6·6 W/cm² the Plexiglas developed internal cavities near the outer edge of the lens, where the thickness was 4 mm. A.

534.26 : 538.566

690. Diffraction of a shock or an electromagnetic pulse by a right-angled wedge. J. B. Keller. *J. appl. Phys.*, **23**, 1267–8 (*Nov.*, 1952).

Graphs of the theoretical pressure distribution resulting from diffraction of a weak shock by a rigid right-angled corner are presented and compared with graphs of measured pressure distributions. The agreement is found to be satisfactory. A graph of the electric field resulting from diffraction of an electromagnetic pulse by a perfectly conducting right-angled corner is also presented. A.

534.27

691. The polarization of acoustic waves in cubic crystals. A. E. Fein and C. S. Smith. *J. appl. Phys.*, **23**, 1212–13 (*Nov.*, 1952).

The directions of particle motion associated with acoustic waves have been computed and are displayed graphically, for each of the three waves, as a function of propagation direction. The numerical example used is cubic nickel and the maximum polarization angle found is 11½ degrees. A.

534.321.4 : 538.551.3

692. Concerning the frequencies resulting from distortion. F. W. Van Name, Jr. Letter in *Amer. J. Phys.*, **20**, 520 (*Nov.*, 1952).

The harmonic frequencies which appear in the analysis of a rectifier circuit [Abstr. 5629 (1952)] are stated not to be physically present at all but to be introduced solely for convenience in the mathematical analysis. R. W. FISH

534.321.9

693. Ultrasonic physics. E. G. Richardson. *London, Elsevier Publishing Company* (1952) x + 285 *pp.* Review in *Research*, **5**, 389 (*Aug.*, 1952).

534.374

694. Acoustical interference filters. K. K. Curtis and L. N. Hadley. *J. Acoust. Soc. Amer.*, **24**, 721–5 (*Nov.*, 1952).

An analysis of the problem of a longitudinal wave normally incident upon the first of the four parallel boundaries separating five distinct media is presented. The filtering action which is characteristic of this physical situation is discussed, and it is found that this arrangement acts as a band pass filter with very narrow pass bands whose centres are separated by a frequency difference primarily dependent upon the thickness of the third medium. On the basis of this analysis, filters have been built which behave experimentally much as they are predicted to behave throughout the frequency region investigated (5000–20 000 c/s). A.

534.41 : 621.317.382.029.5

695. Measuring the mean power of varying-amplitude complex audio waves. H. W. Curtis. *Proc. Inst. Radio Engrs*, **40**, 775–9 (*July*, 1952).

A new instrument which is capable of determining and recording, over successive short-time intervals, the mean-power level of complex audio-waves of rapidly varying amplitude is presented. While designed primarily for research work with speech sounds, where variations of as much as 35 db in level within 1/100 of a second are not uncommon, the unit could be applied to the power-level analysis of any voltage wave varying with components fully within the audio range. The apparatus provides a representation of power level in decibels for the brief phonetic elements of speech or for other similar elements of widely varying amplitude, without confusion of data or ambiguity of interpretation. A.

534.413

696. The operation of acoustic detectors on low-frequency-modulated ultrasound in gases. H. H. Mulwert. Note in *Naturwissenschaften*, **39**, *No.* 15, 349 (1952) *In German.*

Ultrasound, generated by a foil radiator, is modulated by a continuous sound spectrum. A marked difference occurs when the modulated ultrasound is detected by a coal gas or a hydrogen flame. With a coal gas flame it is possible to detect ultrasound of frequencies within the range 18 to 70 kc/s, while with a hydrogen flame 8 cm high the range can be extended to about 170 kc/s. With the coal gas flame, it is necessary to employ a second, unmodulated, beam of ultrasound having a frequency not equal to that of the modulated radiation or its octave. In this case, continual variation of the frequency ratio produces difference tones. The second, unmodulated, beam of ultrasound is not required with the hydrogen flame. A. C. WHIFFIN

534.6 : 534.844

697. A reverberation chamber with polycylindrical walls. J. H. Botsford, R. N. Lane and R. B. Watson. *J. Acoust. Soc. Amer.*, **24**, 742–4 (*Nov.*, 1952).

A reinforced concrete reverberation chamber has been constructed with diffusing cylinders of random size cast in the ceiling and walls. Energy loss in the empty chamber is low because the rigid, heavily enamelled walls have a low absorption coefficient and the attenuation loss in the air is moderate for such a small volume. Materials are tested in the frequency range from 250 c/s to 12 kc/s using half-octave noise bands. A

534.612

698. The upper limit of measuring frequency of the sound pressure measuring equipment by Rayleigh disc in pipe. K. Kato. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 12–15 (1952).

The lowest frequency at which an anomalous rotation of the Rayleigh disk can occur is deduced

theoretically. It is demonstrated that this frequency should be regarded as the upper limit for sound pressure measurements with this type of apparatus.
G. F. HODSMAN

534.612

699. A portable ultrasonic outputmeter and its calibration. K. YOSIOKA AND K. FUJIBAYASHI. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 21–3 (1952).

A Duralumin plate is backed by an air-chamber and mounted at one end of a lever which is pivoted at its other end. The assembly is immersed in water in a box. The buoyancy of the air-chamber is balanced by a spiral spring at the pivot so that the system is just in poise. The sound source to be measured is arranged to radiate in the water and the resulting pressure on the Duralumin plate causes the pivoted lever to rotate by an amount which can be recorded and related to the output of the source. Two methods of calibration are described. G. F. HODSMAN

534.612

700. On the acoustic radiation pressure on a circular disc. J. AWATANI. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 24–36 (1952).

The general formula applicable to any wavelength is derived by introducing oblate spheroidal co-ordinates. Consideration is given to the diffraction by the disk and its inertia effect. The numerical calculation is carried out for values of k (ratio of circumference of disk to wavelength) up to 3·5 and the necessary constants are tabulated. G. F. HODSMAN

534.612

701. The moment of Rayleigh disc by the high frequency sound wave. J. AWATANI. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 37–44 (1952).

Measurements are described with sound of wavelength comparable with the size of the disk. The moment of the disk is found to increase with the frequency when k (ratio of circumference of disk to wavelength), $< 1{\cdot}5$, but decreases rapidly as frequency increases when $k > 1{\cdot}6$. It is concluded that Kotani's formula (1933) is not applicable when $k > 1{\cdot}5$. G. F. HODSMAN

534.612

702. The genuine anomalous action and the displacement law of Rayleigh disc. J. AWATANI. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 45–52 (1952).

A series of measurements with the disk are described using wavelengths comparable with the size of the disk. The angle (θ) at which the disk shows maximum sensitivity increases from 45° as k (ratio of circumference of disk to diameter) exceeds 2. The author terms the relation between θ and k, the "displacement law" of the disk. When $k > 2{\cdot}5$ the disk turns contrary to the usual direction and this is termed the "genuine anomalous action" to distinguish it from that caused by a shielding pipe. G. F. HODSMAN

534.614

703. Systematic errors in indirect measurements of the velocity of sound. P. W. SMITH, JR. *J. Acoust. Soc. Amer.*, **24**, 687–95 (*Nov.*, 1952).

An analysis is made of certain methods of measuring the velocity of sound. Specifically, attention is centred on those methods based upon measurements of the electrical driving-point impedance of the transducer and the observation of some phenomenon of that impedance which is recurrent as the position of the reflector in the acoustic chamber is changed. Consideration is given to the influences of small losses in the propagation of sound in the chamber and of the existence of nonplane wave fronts. It is shown that such measurements can be subject to significant systematic errors arising from the method itself. The nature and magnitude of such errors are discussed. A.

534.62

704. Tube method of measuring sound absorption. H. O. TAYLOR. *J. Acoust. Soc. Amer.*, **24**, 701–4 (*Nov.*, 1952).

A description of a tube method of determining the sound absorbing power of materials in which no exploring device is introduced in the path of the sound wave in the tube. The method is an extension of a research by Kennelly and Kurokawa on "Acoustic Impedance and Its Measurement," and makes use of the motional impedance of a telephone receiver which serves as both the source of the sound wave in the tube and as the means for determining the fraction of sound absorbed by the material, a sample of which is attached to the piston which slides in the tube. Sample calculations for sound absorption are included. A.

534.64

705. Apparatus for absolute measurement of analogous impedance of acoustic elements. G. B. THURSTON. *J. Acoust. Soc. Amer.*, **24**, 649–52 (*Nov.*, 1952).

A hydrodynamical test system for absolute measurement of analogous impedance of acoustic elements is described. The test system is designed for use from 0 to 700 c/s, and in this frequency range it accurately measures pressure and volume flow. A.

534.7 : 612.85

Physiological acoustics. Hearing. *See Abstr.* 1312-16

534.78

706. On the process of speech perception. J. C. R. LICKLIDER. *J. Acoust. Soc. Amer.*, **24**, 590–4 (*Nov.*, 1952).

The process of speech perception is analysed into three main operations: (1) translation of the speech signal into form suitable for the nervous system, (2) identification of discrete speech elements, and (3) comprehension of meaning. The first operation appears to correspond roughly to the transformation made by the sound spectrograph. The second may be carried out by the neural equivalent of a set of matched filters. The third appears to involve a neural form of cross-correlation that exhibits some of the properties of the analogous electronic process. A.

534.78

707. Control tower language. F. C. FRICK AND W. H. SUMBY. *J. Acoust. Soc. Amer.*, **24**, 595–6 (*Nov.*, 1952).

Shannon and others have estimated that written English is about 60% redundant. These estimates are arrived at by considering linguistic constraints on the use of speech symbols, they do not consider additional restrictions imposed by the audience and

the situation in which the speaker finds himself. In order to estimate the effects of such nonlinguistic constraints, an informational analysis has been made of the "sublanguage" used in the control of aircraft by Air Force control tower operators. When the situational, as well as linguistic, contexts are taken into account the estimated redundancy is raised to 96%. A.

534.78

708. Phonemes and allophones in speech analysis. W. F. TWADDELL. *J. Acoust. Soc. Amer.*, **24**, 607–11 (*Nov.*, 1952).

Phonemes are quite abstract units. The criteria for establishing them are primarily distributional and articulatory, not acoustic. A unit intermediate between a single speech-event-segment and a phoneme is the allophone. An allophone is a statistical average, with constant, identifiable acoustic characterization. For many purposes of engineering, psychology, pedagogy and information theory, the allophone may be a more suitable unit than the phoneme. A.

534.78

709. The phonetic basis for identification of phonemic elements. E. FISCHER-JØRGENSEN. *J. Acoust. Soc. Amer.*, **24**, 611–17 (*Nov.*, 1952).

Phonemic analysis must be based to a large extent on considerations of phonetic similarity and difference. For this purpose various stages of the speech event may be chosen, in particular the articulatory, the acoustic, and the auditory stage. It does not seem irrelevant which stage is chosen, for the analysis may give different results in each of the three stages. However, it is usually not possible to state general reasons for preferring one stage over another. In a given language functional reasons may in some cases decide the choice. A.

534.78

710. Operational phonemics in reference to linguistic relativity. K. L. PIKE. *J. Acoust. Soc. Amer.*, **24**, 618–25 (*Nov.*, 1952).

The phonemes of a language are neither absolutes nor bundles of absolute characteristics, but rather are fluctuating bundles of features identified (1) relative to each other in sequences, (2) relative to a system of fluctuating bundles of characteristics, and (3) relative to structural position in a sequence of such relative elements. Detection techniques, if paralleling phonemic analysis, would need to be able to work with fluctuating relative elements rather than with absolute physical characteristics only. A.

534.78

711. The information-bearing elements of speech. G. E. PETERSON. *J. Acoust. Soc. Amer.*, **24**, 629–37 (*Nov.*, 1952).

This study deals with those aspects of speech which are phonetically significant. A technique has been developed with which phonetically equivalent speech samples may be obtained in different phonetic contexts and from different speakers. Data on two front vowels by different types of speakers are presented. The technique has also been applied to the evaluation of words containing these two vowels. A.

534.78 : 612.85

712. A phase-principle for complex-frequency analysis and its implications in auditory theory. W. H. HUGGINS. *J. Acoust. Soc. Amer.*, **24**, 582–9 (*Nov.*, 1952).

A filtering scheme, that utilizes the phase-frequency characteristic of a filter, is shown to have certain advantages for analysing signals, such as speech, which are produced by shock or noise excitation of a physical system having one or more resonances. The phase principle is shown to be particularly well suited to neural mechanisms of inhibition and facilitation, and evidence is presented that such a principle may be used by the ear to achieve its analysis of the sound that it receives. A.

534.785

713. Some experiments on the perception of synthetic speech sounds. F. S. COOPER, P. C. DELATTRE, A. M. LIBERMAN, J. M. BORST AND L. J. GERSTMAN. *J. Acoust. Soc. Amer.*, **24**, 597–606 (*Nov.*, 1952).

Synthetic methods applied to isolated syllables have permitted a systematic exploration of the acoustic cues to the perception of some of the consonant sounds. Methods, results and working hypotheses are discussed. A.

534.83

714. Unsolved basic physical research problems in the field of noise. H. C. HARDY. *J. Acoust. Soc. Amer.*, **24**, 767–8 (*Nov.*, 1952).

Many of the basic unsolved problems in noise research could be attacked by the application of statistical mathematics and techniques instead of use of the conventional "sine wave" approaches. Such techniques could be applied to many sound radiation and diffraction problems. The fields of aerodynamics and acoustics should be brought closer together, which would result in better understanding of the noise of a turbulent medium. Among the various unsolved noise measurement problems are the design of meters for measuring transients, intensity meters and better sound level meters. Several other basic projects are mentioned briefly. A.

534.83 : 532.528

715. An experimental study of single bubble cavitation noise. M. HARRISON. *J. Acoust. Soc. Amer.*, **24**, 776–82 (*Nov.*, 1952).

An experimental study of the noise produced by a single cavitation bubble has been made. The noise consists principally of a transient pressure pulse associated with the collapse of the bubble. The motion of the bubble has been photographed simultaneously with the measurement of the pressure pulse. A.

534.834

716. Techniques for evaluation of noise-reducing piping components. D. B. CALLAWAY, F. G. TYZZER AND H. C. HARDY. *J. Acoust. Soc. Amer.*, **24**, 725–30 (*Nov.*, 1952).

The need for quantitative information on piping noise reduction obtainable by various devices such as flexible couplings, isolating hangers, or pipe-wall damping treatments led to the development of a test set-up consisting of a long, straight length of pipe

in which the test device was installed. Broad-band noise was introduced into the water or the pipe wall at one end of the system. Pipe-wall vibrations were detected by accelerometers and were analysed by means of an octave filter set. It was found that flexible couplings could be rated in terms of the difference in vibration levels at two points on opposite sides of the coupling. Differences of 20 to 45 db were found for some couplings at high frequencies and at atmospheric pressure. The effectiveness of damping treatments which extended along a considerable length of the pipe ranged from 0·2 to 0·5 db per foot. The isolation provided by resilient hangers was measured by comparing pipe-wall and support structure vibrations, but test results must be used with caution since mounting conditions found in practical installations often vary widely from those provided by the test set-up. A.

534.836

717. On average noise level in street. R. TAKEUCHI. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 53–8 (1952).

Each of the sources of sound in a street is considered to be a point source with spherically symmetric radiation at random phase and magnitude. Then the average noise in the street may be considered as the acoustic response of the street to these sources in the steady state. The image source method is used and the treatment is similar to that employed for room calculations. Calculated results are shown to be in agreement with observed measurements.

G. F. HODSMAN

534.837

718. Unsolved problems in the field of aircraft noise. R. O. FEHR. *J. Acoust. Soc. Amer.*, **24**, 772–5 (*Nov.*, 1952).

Noise-control problems in connection with turbojet engine testing as well as operation are experienced by the engine manufacturer, the airframe manufacturer and the operators of aircraft and of airports. Some of these noise-control problems can be solved by isolation of the noise source, others require reduction of the noise at the source. The important still unsolved problems are stated, together with background information, which it may be useful to know when attempting their solution. A.

534.843

719. The analysis of the sound field in a room by the image source method. II. R. TAKEUCHI. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 60–4 (1952).

The method is similar to that previously described [Abstr. 2576 (1952)] but the treatment is applied to the case where the sound-source radiates a pulse. Some practical illustrations of the theory are given.

G. F. HODSMAN

534.843.5

720. The analysis of transitory acoustic phenomena on reduced scale models. T. KORN AND F. KIRSCHNER. *Ann. Télécomm.*, **7**, 414–20 (*Oct.*, 1952) *In French.*

To determine the intelligibility of speech in a room, it is not adequate merely to analyse the effect of materials. Speech involves transitory phenomena and a method is described for their study, using reduced scale models. Details of the installation are given together with the results obtained. The importance of the geometric factor which influences the transitory speech phenomena, and hence the intelligibility in the room, is stressed. G. F. HODSMAN

534.862.3/.4 : 621.395.61/.62

721. Two applications of the concept of spatial distortion. J. BERNHART. *Onde élect.*, **32**, 334–43 (*July*, 1952) *In French.*

Consideration is given to spatial distortion introduced both at the sound source and sound reproduction ends of electroacoustic transmission systems. Stereophonic reproduction is considered as a particular case of the general theory. Practical applications and specimen results are also given. G. F. HODSMAN

OPTICS . RADIATION . SPECTRA 535

535 : 665.5

Optics in the oil industry. *See Abstr.* 1320

535.231.4

722. Emissivity for CO_2 at elevated pressures. R. J. HOLM, D. WEBER AND S. S. PENNER. Letter in *J. appl. Phys.*, **23**, 1283 (*Nov.*, 1952).

Total absorptivity measurements were carried out at room temperature as a function of partial CO_2 pressure and of total pressure with nitrogen as pressurizing gas. The results agree well with the emissivity data of Hottel and Mangelsdorf (1935). Above 1 atm. (up to 21 atm.) the absorptivity is insensitive to changes in the total pressure. The ratio of rotational line width to line spacing is large for CO_2: this explains the observed insensitivity. This can be extrapolated to higher temperatures.

A. J. TAYLOR

535.233

723. A precision color temperature meter for tungsten illumination. G. H. DAWSON, D. E. GRANT AND H. F. OTT. *J. Soc. Motion Picture Televis. Engrs*, **59**, 309–12 (*Oct.*, 1952).

The meter uses red and blue filters. A special logarithmic diaphragm largely eliminates undesirable effects of nonuniform response over the cell area and aids accurate setting of the red filter standard at high intensities. A.

535.31 : 535.12

724. On the most simple solution, in polar coordinates, of Maxwell's equations, and their application to formulae for vitreous refraction in lenses, and on Huyghen's principle. A. FOIX. *J. Phys. Radium*, **13**, 445–50 (*Oct.*, 1952).

A simple form of wave function, satisfying Maxwell's equations, is derived and is shown to lead to the fundamental optical formulae and to answer previous criticisms of these formulae. R. W. FISH

535.317.1 : 621.391

725. Transfer to the domain of optics of certain results of the theory of information. A. BLANC-LAPIERRE. *Bull. Soc. Franç. Elect.* (*Sér.* 7) **2**, 481–8 (*Aug.*, 1952) *In French.*

The relationship between an incoherent object and

its diffracted image formed through an aperture is derived. The transformation from object to image has the same form as that of a low-pass filter. The loss in detail is due to the suppression of the "high-frequency" components of the signal—the reduction in intensity is due to the transmission loss of the filter. No subsequent correction of the image can correct for the loss of detail, but in theory the intensity distortion could be corrected by a further filter with a compensating attenuation characteristic. An expression is derived for the quantities of information corresponding to the object and image. The fluctuations in the object intensity and the defects in the means of viewing or recording the image play the part of noise in a communication system.

W. T. BLACKBAND (R)

535.325

726. Refractivity of organic vapours. S. VENKATARAMAN. Letter in *Curr. Sci.*, **21**, 241 (*Sept.*, 1952).

Values are given for the refractivities of benzene, carbon tetrachloride, cyclohexane, methyl acetate and methyl alcohol. The variation with temperature is found and compared with theory. The agreement is within 1·7%. The results were obtained using a Rayleigh refractometer [see also Abstr. 8773 (1952)]

H. G. JERRARD

535.33.03

727. Mechanism of the influence of [impurities on] line intensity in flame photometry. K. SCHAFER AND K. STAAB. Letter in *Naturwissenschaften*, **39**, *No.* 16, 375–6 (1952) *In German.*

The intensity of lines due to neutral K atoms depends on the equilibrium $K \rightarrow K^+ + e^-$, which is disturbed by the presence of other ionizable atoms in accordance with the law of mass-action. An equation is developed and tested for K, Na mixtures.

G. F. LOTHIAN

535.33.07–14 : 537.228.5

728. A broad-band, coaxial Stark cell for microwave spectroscopy. L. J. RUEGER AND R. G. NUCKOLLS. *Rev. sci. Instrum.*, **23**, 635 (*Nov.*, 1952).

A coaxial-type Stark cell was designed as a conveniently small-sized apparatus for operation at all microwave frequencies between 3400 and 900 Mc/s (and lower) without changing either the sample under investigation or the size of the absorption cell. The Stark voltage is applied between the inner and outer conductors of the coaxial line and is separated from the r.f. signal at each end of the cell by sections of waveguide. The use of this cell has permitted the extension of microwave absorption measurements in gases to a new and extremely low range of frequencies. It was used to discover and investigate the full series of ND_3 absorption lines in this new range. A.

535.33.07–14 : 538.615

729. Apparatus for Zeeman effect measurements on microwave spectra. J. R. ESHBACH AND M. W. P. STRANDBERG. *Rev. sci. Instrum.*, **23**, 623–8 (*Nov.*, 1952).

Apparatus and experimental techniques for Zeeman-effect measurements on microwave spectra are described. The method uses a waveguide type absorption cell and provides for either π- or σ-type observations. Molecular rotational and nuclear gyromagnetic ratios are found to be measurable to about 1% accuracy. A method is presented for sign determination of these gyromagnetic ratios using circularly polarized microwaves. The microwave components used in setting up the circularly polarized waves are described. A.

535.33.07–15

730. Infra-red spectrometry and its recent progress. J. LECOMTE. *Cahiers de Phys.*, *No.* 38, 26–54 (*July*, 1952) *In French.*

A review of instrumental developments including detectors, spectrometers, recording arrangements, reflecting microscopes, polarizers and filters. An image convertor and a detector both employing the heating of liquid films are described. D. H. WHIFFEN

535.337 : 535.338.42

731. Perturbation of electronic bands of NO in the medium ultra-violet region by argon and by nitrogen at pressures up to 1000 atmospheres. J. GRANIER-MAYENCE AND S. ROBIN. Letter in *J. Phys. Radium*, **13**, 494–6 (*Oct.*, 1952) *In French.*

Quantitative studies of the broadening and wavelength-shift of the γ-bands at 2050, 2150 and 2260 Å are reported. The effect of N_2 on the fundamental band of NO at 5·3 μ has also been examined.

R. F. BARROW

535.338.3 : 538.615

732. A theoretical study of the intensity and of the Zeeman effect of the helium intercombination lines. P. PLUVINAGE. *J. Phys. Radium*, **13**, 405–11 (*July–Aug.–Sept.*, 1952) *In French.*

Standard methods of theoretical spectroscopy are shown to account for all experimental results.

L. PINCHERLE

535.338.32

733. The quenching of mercury resonance radiation. II. The production of metastable ($^3P_0$) atoms. B. DE B. DARWENT AND F. G. HURTUBISE. *J. chem. Phys.*, **20**, 1684–8 (*Nov.*, 1952).

For Pt I, see Abstr. 2510 (1951). The production of metastable ($^3P_0$) mercury atoms in the quenching of mercury resonance radiation has been investigated with N_2, H_2, C_2H_4, C_2H_6, O_2 and CO_2. Metastable atoms, by virtue of their ability to induce the emission of electrons from a nickel surface, were detected with the first four gases; none was detected with O_2 and CO_2. A.

535.338.4

734. Contribution to the study of the emission spectra of ammonia and of heavy ammonia: the transition $^1\Pi - {}^1\Delta$ of the radicals NH and ND. R. FLORENT AND S. LEACH. *J. Phys. Radium*, **13**, 377–85 (*July–Aug.–Sept.*, 1952) *In French.*

Analysis of the 1, 0, 0, 0 and 0, 1 bands are reported. The values of the derived constants (cm^{-1}) are listed below:

		ω_e	$x_e\omega_e$	B_e	α_e
NH	$c^1\Pi$	2502	190	14·81	1·38
	$a^1\Delta$	3314	63	16·78	0·67
ND	$c^1\Pi$	1828	101	7·89	0·52
	$a^1\Delta$	2421	34	8·96	0·24

The separation of the states $a^1\Delta - X^3\Sigma^-$ is about 1·2 eV.

R. F. BARROW

535.338.4

735. Spectral studies of ozoniser discharges in nitrogen. R. K. ASUNDI AND N. APPALANARASIMHAM. Letter in *Curr. Sci.*, **21**, 240–1 (*Sept.*, 1952).

Band systems of N_2 in this source are listed with visual estimates of intensity. Many singlet systems occur and some new progressions. N_2 1st positive bands are weak and NO is absent. A. G. GAYDON

535.338.4

736. Rotational analysis of the colombium oxide bands. K. SURYANARAYANA RAO. Letter in *Nature* [*London*] **170**, 670 (*Oct.* 18, 1952).

535.338.4

737. Behaviour of chlorobenzene during a glow discharge. H. SCHÜLER AND L. REINEBECK. *Naturwissenschaften*, **39**, *No.* 19, 445–7 (1952) *In German.*

Spectral lines have been investigated, appearing in the spectra of a glow discharge in an atmosphere consisting of C_6H_5Cl (pressure from 0·05 to 1 mm) and one of the following gases: He, Ne, A, Kr and Hg vapour (pressure *c.* 0·4 mm) [see also Abstr. 6110 (1951)]. The following "fragments" have been detected spectroscopically: H, C, H_2, C_2, CH, Cl, Cl^+, HCl^+, CCl and C_2H_x ($x = 1$, 2 or 3), with the inert gases, and HgH and HgCl with Hg vapour. The "T-spectrum" (carrier C_2H_x) appears only when the excitation occurs in the He discharge. The benzene spectrum (2603 Å) has been observed only when neither the inert gas nor the "fragment" lines have been visible. Continua due to unknown carriers have been observed in experiments with inert gases.

F. LACHMAN

535.338.4 : 539.132 : 551.593.9

738. Intensity distribution in the rotation-vibration spectrum of the OH molecule. H. S. HEAPS AND G. HERZBERG. *Z. Phys.* **133**, *No.* 1–2, 48–64 (1952).

The rotation-vibration spectrum of OH has been observed by Meinel in the light of the night sky. For the purpose of establishing the mechanism leading to this emission calculations have been made of the intensity distribution in the vibration spectrum of a Morse oscillator equivalent to the OH molecule. On the assumption of a linear dipole moment variation an explicit formula for the transition probabilities is obtained and the numerical values are evaluated up to $v = 12$. If the assumption is made that the OH molecules in the night sky are first formed in the $v = 9$ level and then cascade down to $v = 0$ an intensity distribution similar to the observed is found. The effect of a quadratic term in the dipole moment is also considered. The matrix elements of this quadratic term are evaluated up to $v' = 8$ and $v'' = 3$. By introducing these quadratic terms into the transition probabilities a fair quantitative agreement is obtained between observed and calculated relative intensities. Predictions are made for the intensities of the OH bands of the $\Delta v = 1$, 2 and 3 sequences which lie in the farther infrared not yet investigated in the night sky. A rough estimate of the number of OH molecules formed in the upper atmosphere in the $v = 9$ level per second and per cm² column is 9×10^{11}. A.

535.338.42 : 536.462

739. The flame emission spectrum of HBr. B. W. BULLOCK, C. E. FEAZEL, P. GLOERSEN AND S. SILVERMAN. Letter in *J. chem. Phys.*, **20**, 1808–9 (*Nov.*, 1952).

Observations at 2600 cm^{-1} lead to rotational and vibrational flame temperatures of about 1400°K.

R. F. BARROW

535.343 : 535.375.5

740. Absorption spectra at low temperature. Study of N_2O gas, NO gas and liquid. J. MAYENCE. *Ann. Phys.* [*Paris*] **7**, 453–505 (*July–Aug.*, 1952) *In French.*

Absorption cells and cryostats used are described. N_2O gas at 18°C has peaks of absorption at 1840 and 1450 Å. There is no evidence of photodissociation to NO for wavelengths down to 1390 Å. NO gas shows no absorption peaks in the range 4000–8500 Å. Vibrational peaks are tabulated for the range 2267–1549 Å; superposed on these are continuous bands with peaks at 1820 and 1470 Å. The former is attributed to N_2O_2 and the latter to a $^a\pi \rightarrow {}^a\pi$ transition of NO; satisfactory potential curves for the two states are calculated. The Raman spectrum of liquid NO shows lines at 259 and 1862 cm^{-1}; the former is attributed to N_2O_2 and the latter corresponds to a vibrational frequency of NO gas. 80 references. G. F. LOTHIAN

535.343–14

741. Six-millimeter spectra of OCS and N_2O. S. J. TETENBAUM. *Phys. Rev.*, **88**, 772–4 (*Nov.* 15, 1952).

The $J = 3 \rightarrow 4$ pure rotational transition of OCS and the $J = 1 \rightarrow 2$ transition of N_2O have been investigated. The molecules were in their normal isotopic abundances. The results are compared with those of previous investigators. Quadrupole hyperfine structure, *l*-type doubling and Fermi resonance effects are analysed. A.

535.343–14 : 539.133

742. Microwave spectra and structures of XYH_3 molecules. J. M. MAYS AND B. P. DAILEY. *J. chem. Phys.*, **20**, 1695–1703 (*Nov.*, 1952).

Work on the microwave spectra of CH_3Cl, SiH_3Cl, GeH_3Cl, CH_3Br, SiH_3Br and GeH_3Br is summarized, and preliminary reports of work are expanded. Structural parameters, dipole moments and quadrupole coupling constants obtained from analysis of these spectra are tabulated and discussed, and a unified picture of the bonding in these series of molecules, based on the derived quantities, is presented. A.

535.343–14 : 539.181

743. Radiofrequency spectra of Li^6F^{19} by the molecular beam electric resonance method. J. C. SWARTZ AND J. W. TRISCHKA. *Phys. Rev.*, **88**, 1085–92 (*Dec.* 1, 1952).

The electric resonance method of molecular beam spectroscopy has been used to study the rotational Stark transitions J, $m_J \rightarrow J$, m_J' for Li^6F^{19}. A new type of homogeneous electric field of high resolution was used to observe the transitions. A mass spectrometer was used to separate the Li^6 (8% abundant) and Li^7 (92% abundant) positive ions coming from the hot wire detector. From observations of the $1, \pm 1 \rightarrow 1, 0$ and $2, \pm 2 \rightarrow 2, \pm 1$ transitions for a variety of electric field strengths it was concluded that the principal nuclear molecular interaction was of the

type specified by the operator $c\mathbf{I}\cdot\mathbf{J}$, where c is a constant, $\mathbf{I}$ is the spin of the F nucleus, and $\mathbf{J}$ is the rotational quantum number. The effects of the Li^6 quadrupole and $\mathbf{I}\cdot\mathbf{J}$ interactions were below the limits of observation. The constant c/h was found to be $+37{\cdot}3 \pm 0{\cdot}7$ kc/s for both transitions. This value is approximately twice that calculated from molecular beam magnetic resonance experiments at strong fields. Using the electric resonance strong field data, calculations determined the constant $\mu^2 A$ to be $(747{\cdot}2 \pm 0{\cdot}9) \times 10^{-76}$ c.g.s. units for the lowest vibrational state. This quantity for the next vibrational state was greater by $(4{\cdot}3 \pm 0{\cdot}1)\%$. μ is the electric dipole moment, and A is the moment of inertia of the molecule. A.

535.343–15

744. The infrared spectra of NF_3 and PF_3. M. K. Wilson and S. R. Polo. *J. chem. Phys.*, **20**, 1716–19 (*Nov.*, 1952).

The infrared spectra of NF_3 and PF_3 have been investigated with a prism instrument in the range 250 cm^{-1} to 5000 cm^{-1}. The fundamental frequencies are, for NF_3, $\nu_1(A_1) = 1032$ cm^{-1}, $\nu_2(A_1) = 647$ cm^{-1}, $\nu_3(E) = 905$ cm^{-1} and $\nu_4(E) = 493$ cm^{-1}; and for PF_3, $\nu_1(A_1) = 892$ cm^{-1}, $\nu_2(A_1) = 487$ cm^{-1}, $\nu_3(E) = 860$ cm^{-1} and $\nu_4(E) = 344$ cm^{-1}. Force constants as well as thermodynamic functions are calculated for both molecules. A.

535.343–15

745. The infrared spectrum of SO_2F_2. W. D. Perkins and M. K. Wilson. *J. chem. Phys.*, **20**, 1791–4 (*Nov.*, 1952).

This was investigated between 240 cm^{-1} and 4000 cm^{-1} with a prism spectrometer. Seven of the nine fundamentals were observed and assigned to their appropriate symmetry species. Ten additional bands were assigned as combinations or overtones. A partial force constant calculation has been made. A.

535.343–32

746. Search for weak absorption bands of benzonitrile in the near ultraviolet. R. C. Hirt and F. T. King. Letter in *J. chem. Phys.*, **20**, 1821 (*Nov.*, 1952).

Purified benzonitrile shows no trace of a band at 33 000 cm^{-1} mentioned by McConnell [Abstr. 5227 (1952)]. Weak bands are found at 31 000 and 31 900 cm^{-1}. G. F. LOTHIAN

535.343.2 : 535.372

747. Theory of luminescence and optical absorption by admixtures in dielectrics. S. I. Pekar. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 642–57 (1952) *In Russian.*

The theoretical conclusions arrived at refer only to simple absorption and luminescence bands, i.e. those corresponding to a single electron transition $s_1 \leftrightarrows s_2$. They also refer only to cubic ionic crystals in which the polarization oscillations may be approximately characterized by a single eigenfrequency ω. Further conditions of validity of the theory are small amplitudes of ion vibrations, large effective radii of the ψ-functions of the electrons, spectrum of the admixture luminescence situated between the range of i.r. ionic absorption and the absorption range of strongly bound electrons. The conclusions are: (1) the absorption and corresponding luminescence spectrum are in the mutual relation of mirror symmetry. This applies not only to ionic, but to all dielectric crystals; (2) in all crystals and in all types of "centres" the absorption and the fluorescence spectra are similar. Their form is determined by general formulae involving two parameters a and ω which depend on the crystal and type of "centre"; (3) the absorption (luminescence) bands have bell-shape which at low temperatures is independent of the temperature. At high temperatures the half-breadth of the bands increases proportionally to the square root of the absolute temperature. The half-breadth of absorption and luminescence bands is related by simple formulae to the Stokes displacement. The energy of the thermal excitation of the electrons of a "centre" is related to the position of the maxima of both bands by a formula valid for ionic and other dielectric crystals. Coloured alkali-halide crystals have a well-defined fluorescence band. B. F. KRAUS

535.343.2 : 535.5

748. Absorption spectra of benzene monocrystals in polarized light. V. L. Broude and A. F. Prikhotko. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 605–9 (1952) *In Russian.*

Optical absorption spectra in benzene crystals are investigated for oscillations of the field vector parallel to the 3 axes of symmetry of the crystal. Series of weakly polarized absorption bands are observed in all cases; strongly polarized absorption bands are visible in the spectra for the $\bar{a}$ and $\bar{c}$ directions, but absent in the spectra for the $\bar{b}$ direction. From the comparison of the experimental and theoretical results the symmetry of the prohibited transition in benzene could be determined unambiguously as $A_{1g} \rightarrow B_{2u}$. An interesting fact is that this problem was solved by investigating not the molecular, but the crystal spectrum. From the intensity of the bands of the "molecular" series in all three directions in the crystal the position of the molecules in the lattice can be determined. This requires only intensity measurements. The case of the benzene crystal, for which the position of the molecules is known, furnishes a check. This possibility is very important for crystals for which the lattice is known but not the arrangement of the molecules. B. F. KRAUS

535.343.2–12

749. On the existence of two distinct causes of Debye absorption in Hertzian spectra. Application to semiconductors. M. Freymann and R. Freymann. *C.R. Acad. Sci.* [*Paris*] **235**, 1125–7 (*Nov.* 10, 1952) *In French.*

Note suggesting that absorption from 10^2 to 10^6 c/s in ZnO, TiO_2, V_2O_5, UO_2, U_3O_8, etc., and possibly NaCl, RbI, etc., and even HBr, HI, etc., is due to reorientation of pairs of + and − lattice defects. D. H. WHIFFEN

535.343.3–15 : 539.132 : 536.71

Infrared spectra of normal and deuterated ethyl alcohol. *See Abstr.* 822

535.343.4

750. Separation of the absorption spectra of NO_2 and N_2O_4 in the range of 2400–5000 Å. T. C. Hall, Jr and F. E. Blacet. *J. chem. Phys.*, **20**, 1745–9 (*Nov.*, 1952).

The individual absorption coefficient curves of NO_2

and N_2O_4, separated by means of mechanical analogue differential analyser are presented. Beer's law is assumed to be applicable to the system. A discussion of the apparently continuous nature of the N_2O_4 absorption is included. A.

535.343.4–14

751. Preliminary analysis of the pure-rotational spectrum of methyl amine. D. R. LIDE, JR. Letter in *J. chem. Phys.*, **20**, 1812–13 (*Nov.*, 1952).

535.343.4–15

752. On the infrared spectrum of methyl chloroform. P. VENKATESWARLU. Letter in *J. chem. Phys.*, **20**, 1810 (*Nov.*, 1952).

See also Abstr. 4250 (1951). As the data given previously do not agree with those of El-Sabban *et al.* [Abstr. 7735 (1951)] it is pointed out that three peaks near 3014 cm^{-1}, which are considered by them to be three different combinations, are in fact the *P*, *Q* and *R* branches of the vibration ν_7. Because of new results and polarization data the original assignment is slightly modified. A. J. TAYLOR

535.343.4–15

753. Vibrational assignments for 1, 1, 1-trichloroethane. M. Z. EL-SABBAN, A. G. MEISTER AND F. F. CLEVELAND. Letter in *J. chem. Phys.*, **20**, 1810–11 (*Nov.*, 1952).

See also preceding abstract. It is pointed out that, although Venkateswarlu's assignment may be correct, the assignment mentioned previously by the authors is also possible and more probable: the calculated values of the frequencies agree better with the observed values. Venkateswarlu's assignment also assumes that the C–C stretching frequency is low because of the great mass of the CCl_3 group. It is shown that this may be unjustified. A. J. TAYLOR

535.343.4–15

754. Induced infrared absorption in hydrogen and hydrogen foreign gas mixtures at pressures up to 1500 atmospheres. D. A. CHISHOLM, J. C. F. MACDONALD, M. F. CRAWFORD AND H. L. WELSH. Letter in *Phys. Rev.*, **88**, 957 (*Nov.* 15, 1952).

Extension of earlier work [Abstr. 2538 (1951)] to higher pressures shows a splitting of the *Q* branch into two components. G. F. LOTHIAN

535.343.4–15 : 535.375.55

755. The Raman and infrared spectra of CF_3Br and CF_3I. W. F. EDGELL AND C. E. MAY. Letter in *J. chem. Phys.*, **20**, 1822–3 (*Nov.*, 1952).

A preliminary report is given of the Raman spectra of the liquids, measured at −100°C and −40°C respectively, and the infrared spectra of the vapours. G. I. W. LLEWELYN

535.343.4–15 : 535.375.56

756. The infrared and Raman spectra of CF_3OF. R. T. LAGEMANN, E. A. JONES AND P. J. H. WOLTZ. *J. chem. Phys.*, **20**, 1768–71 (*Nov.*, 1952).

The infrared spectrum has been obtained for gaseous CF_3OF from 2 to 25 μ. The Raman shifts have been measured for the liquid. Nine of the twelve fundamental vibration frequencies have been assigned and an interpretation made of the observed spectra on the basis that CF_3OF belongs to point group C_s. A.

535.343.4–32

757. On the new absorption bands of the oxygen molecule in the far ultraviolet region. Y. TANAKA. *J. chem. Phys.*, **20**, 1728–33 (*Nov.*, 1952).

The bands were studied using a 3 m grazing incidence vacuum spectrograph. Two new progressions of bands were found in the region between 1200 Å and 1290 Å (one of which is considered to be a member of the Rydberg series converging to the first ionization potential of the O molecule). There were also observed a few short continua near the short wavelength end of the Schumann–Runge absorption continuum. The behaviour of three strong and diffuse bands, at 1200 ~ 1290 Å, were studied at pressures ranging from 0·01 to several mm of Hg. Assuming the diffuseness of these bands as being due to predissociation, the existence of O atoms in ^1S metastable states in the upper atmosphere is briefly discussed. A.

535.345

758. The nature of the thermal color change in zinc oxide. C. K. COOGAN AND A. L. G. REES. Letter in *J. chem. Phys.*, **20**, 1650–1 (*Oct.*, 1952).

The change in colour from white to yellow on heating zinc oxide was formerly attributed to partial dissociation giving rise to excess zinc. This is not likely at temperatures ¼ that of the melting point. Coloration is more likely to be due to a shift in the lattice absorption edge with temperature. G. F. J. GARLICK

535.345

759. Near-infrared absorption by entire bands of carbon dioxide. J. N. HOWARD AND R. M. CHAPMAN. Letter in *J. Opt. Soc. Amer.*, **42**, 856 (*Nov.*, 1952).

See also Abstr. 6407 (1952). In order to make applications to atmospheric transmission problems, the 2·7 μ and 4·2 μ bands of CO_2 were studied in a way similar to that used for the water vapour bands. Optical path lengths (from 4 to 16 m), partial pressures (10–50 mm Hg), and total pressures (50–760 mm Hg) could be varied independently. It was found that the absorption occurs mainly between 3520 and 3820 cm^{-1} (2·7 μ bands) and between 2225 and 2405 cm^{-1} (4·2 μ bands). An empirical relation is derived for the average absorption of each entire band, which involves a correction for CO_2 self-broadening. The relation predicts correctly the absorption of these bands for higher concentrations. A. J. TAYLOR

535.345

760. Absorption by pyrimidines of plane polarized ultraviolet light. L. E. LYONS. Letter in *J. chem. Phys.*, **20**, 1814 (*Nov.*, 1952).

Absorption by 2-amino-4 chloro-6 methyl pyrimidine (P) and 2-chloro-4, 6-dimethyl pyrimidine (Q) reveals three bands interpreted as one n–π (weak) band and two π–π bands. Knowing the crystal structure of P, the bands may be assigned experimentally. Although the crystal structure of Q is unknown, comparison between corresponding bands of Q and P for different planes of polarization of incident light enables an assignment of the Q bands to be made. H. H. GREENWOOD

535.345 : 535.434

761. Constancy of the products $A\lambda$ and $D\lambda$ in the absorption and scattering of photons. L. AKOBJANOFF. *C.R. Acad. Sci.* [*Paris*] **235,** 612–13 (*Sept.* 22, 1952) *In French.*

The absorption of light by suspensions of black particles in water and the scattering of light by non-absorbing white particles are both shown to be inversely proportional to wavelength over the range 350–1050 mμ. The size of the particles and their concentration are shown to affect the constants obtained. R. W. FISH

535.345 : 539.132

762. Integrated absorption for vibration-rotation bands of CO_2. D. WEBER, R. J. HOLM AND S. S. PENNER. Letter in *J. chem. Phys.*, **20,** 1820 (*Nov.*, 1952).

Quantitative measurements using the Wilson and Wells extrapolation procedure with He as pressurizing agent were carried out; results show fair agreement between experimentally determined values. J. JACOBS

535.345 : 548.0

763. Optical properties of crystalline thoria. O. A. WEINREICH AND W. E. DANFORTH. Letter in *Phys. Rev.*, **88,** 953 (*Nov.* 15, 1952).

Heating of oxygen-rich crystals to 1000°C in air reddens the crystals, heating in vacuum or hydrogen bleaches them. The absorption peak at 4000 Å in vacuum is probably due to excess thorium. Rapid quenching gives a deep black colour, the crystals are opaque from 0·2–2 μ. There is no photoconductivity and no electrolytic decomposition as for oxygen-poor crystals. C. TURNER

535.345.6

764. The design of optical filters. L. I. EPSTEIN. *J. Opt. Soc. Amer.*, **42,** 806–10 (*Nov.*, 1952).

According to Herpin's theorem, a symmetrical thin-film combination is equivalent, at one wavelength, to a single film, characterized by an equivalent index and equivalent thickness. If a large number of identical non-absorbing thin-film combinations are combined, the resulting periodically stratified medium acts as a band-stop filter. In a stop band, the equivalent index of a symmetrical period is a pure imaginary; in a pass band, it is real. Equivalent indices are given for some commonly used periods. These may have values not possessed by any existing substance. These periods have proved useful in the design of optical filters and antireflection coatings. A.

535.345.6

765. Optical filters. N. M. MOHLER AND J. R. LOOFBOUROW. *Amer. J. Phys.*, **20,** 499–515 (*Nov.*); 579–88 (*Dec.*, 1952).

This survey of filters useful in optical work includes the range from ultraviolet through infrared. It describes absorption filters making use of solid, liquid and gaseous absorbers, and polarization, interference and Christiansen types of filter as well as devices occasionally used in lieu of filters such as focal isolation and residual ray apparatus, gratings and powder films used effectively as scatterers. A.

535.371

766. Luminescence of cadmium sulphide single crystals in strong direct electric fields. K. W. BÖER AND U. KÜMMEL. *Z. phys. Chem.*, **200,** 193–8 (*Sept.*, 1952) *In German.*

Cadmium sulphide single crystals show a luminescence in strong electric fields at values under the dielectric breakdown voltage. Just under this voltage the conductivity takes a sharp leap upwards. This effect is reversible until the thermal discharge sets in. The luminescence shows no fatigue even after some hours. It is considered that both the luminescence and the abnormal conductivity are due to the field excitation of electrons to the conduction band and certainly not to thermal excitation. J. EWLES

535.371

767. Quantitative absorption and emission measurements of the acridine orange cation, at normal and low temperature in an organic solvent, and its contribution to the interpretation of the problem of meta-chromatic fluorescence. V. ZANKER. *Z. phys. Chem.*, **200,** 250–92 (*Sept.*, 1952) *In German.*

Even at normal temperatures in alcohol-ether-water mixtures a tendency to association exists, which is much enhanced by lowering of temperature. At −175° dimers and tetramers occur for which the association constants and free energy of association have been determined. Fluorescence measurements show that in emission, as in dilute solution, a short-lived fluorescence, and a long-lived phosphorescence process occur. The dependence on concentration of the absorption and emission intensity suggests that this variability is due to changes of electron-nucleus coupling. Appeal is made to the Franck–Condon principle for an interpretation. The characteristic change of colour, depending on concentration, is ascribed to a varying participation of two emission processes. One is recognized as fluorescence from an electronic singlet state, the other as a triplet-singlet combination. See also Abstr. 5674 (1952).

J. JACOBS

535.371

768. On the problem of fluorescence quenching by foreign substances. G. KORTÜM, H. BAUR AND G. FRIEDHEIM. *Z. phys. Chem.*, **200,** 293–301 (*Sept.*, 1952) *In German.*

Previous work suggests that quenching by inorganic ions is generally "dynamic," involving collisions between excited molecules and foreign molecules, whereas organic quenchers operate partly in this way, and partly by a "static" mechanism: this is the association of potentially fluorescent molecules with others to form non-fluorescent complexes. The present experiments on the absorption spectra and fluorescence intensity at various temps. of eosin, acridine and uranin, with phenol, KI and aniline as quenchers, fail to separate the dynamic and static mechanisms, which probably exist side by side.

S. T. HENDERSON

535.371

769. Luminescence of aqueous solutions of radioactive isotopes and the Čerenkov effect. E. H. BELCHER. *Nature* [*London*] **170,** 571–2 (*Oct.* 4, 1952).

Luminescence of low intensity in aqueous solutions of isotopes emitting β-particles may be due to excitation of the substrate or to the Cherenkov effect. From the theory of Frank and Tamm it is evident that

solutions containing S^{35} and Ca^{45} show substrate excitation. Experiments with Fe^{59}, I^{131}, Au^{198}, P^{32} and K^{42} indicate that the respective emissions arise mainly from the Cherenkov effect. G. F. J. GARLICK

535.371

770. On the luminescence of divalent manganese in solids. C. C. KLICK AND J. H. SCHULMAN. *J. Opt. Soc. Amer.*, **42**, 910–16 (*Dec.*, 1952).

It is shown that, under certain conditions, measurements on the emission and absorption of luminescent centres allow the determination of the configurational co-ordinate curves for the ground and excited states of the centres. The method is used as a first approximation in obtaining configurational co-ordinate curves for divalent manganese in zinc silicate. These curves offer an explanation of the asymmetry of the manganese emission. Comparison of the energy levels for the manganese ion in the solid and gaseous state leads to an identification of the various levels and to the suggestion that emission in the solid state corresponds to a $4_G \rightarrow 6_S$ transition. A.

535.371

771. Radiofrequency field quenching of ultraviolet excited phosphors. T. MILLER. *J. appl. Phys.*, **23**, 1289–93 (*Dec.*, 1952).

This has been investigated for a number of sulphide phosphors. The phosphor layer is sandwiched between two parallel plane electrodes. The r.f. potential is applied to the electrodes. Data are presented showing the dependence of the quenching action on field strength, field frequency and ultraviolet excitation. The quenching response to an amplitude modulated r.f. potential and the fatigue effects resulting from prolonged exposure to the r.f. field have also been investigated. A.

535.371

772. New kind of luminescence in fused quartz and Plexiglass. G. V. OVECHKIN. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 610–16 (1952) *In Russian.*

A new kind of luminescence has been observed on Plexiglass and fused quartz specimens when irradiated with u.v. radiation and simultaneously subjected to the action of a certain deformation wave of short duration. The specimens themselves are not coloured during this process. The afterglow is of a relatively long duration, and fused quartz acquires the property of thermoluminescence. The thermoluminescence spectrum of fused quartz is shifted towards longer waves with regard to the afterglow spectrum.

F. LACHMAN

535.371

773. On the development history of infrared-sensitive phosphors. K. PRZIBRAM. Note in *Naturwissenschaften*, **39**, *No.* 18, 425 (1952) *In German.*

See Abstr. 6419 (1952).

535.375.5

774. Line width in the Raman spectra of some hydrocarbons. I. M. M. SUSHCHINSKIĬ. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 755–68 (1952) *In Russian.*

Describes a method of evaluating the line widths of Raman spectra, based on the comparison of the integral intensities with the intensities at the maximum of the lines. This method has been used for the study of the line width in the spectra of paraffin hydrocarbons. The close connection between the line width and other line parameters (place of the lines in the spectrum, degree of depolarization, intensity) is explained. A method has been deduced for evaluating the intensities at the line maxima from those obtained by photoelectric method. F. LACHMAN

535.375.54

775. Raman spectrum of carborundum. P. S. NARAYANAN. Letter in *Curr. Sci.*, **21**, 239–40 (*Sept.*, 1952).

The significance of an observed sharp Raman line with a frequency shift of 818 cm^{-1} is briefly discussed.

G. I. W. LLEWELYN

535.376

776. Field strength and temperature studies of electroluminescent powders in dielectric media. S. ROBERTS. *J. Opt. Soc. Amer.*, **42**, 850–4 (*Nov.*, 1952).

Electroluminescent cells are constructed by dispersing a copper-activated zinc sulpho-selenide phosphor powder in a thermoplastic dielectric matrix. The resulting sheet material is observed to glow when an alternating electric field is applied. The light produced is not continuous, but flickers with twice the applied frequency, dropping to zero between flashes. The electric field in the phosphor particles can be calculated if the particles are assumed to be spheres; however, it is first necessary to determine their dielectric constant. This is done by comparing the dielectric constant of the phosphor-plastic aggregate with that of the clear plastic. The results of these calculations show that, for a variety of plastic matrix materials having different dielectric constants, the brightness of electroluminescence depends only on the electric field in the phosphor particles. A cell having a matrix of polystyrene was used in studying the brightness of electroluminescence *v.* temperature. This material has a relatively small temperature coefficient of dielectric constant. Only a small change of brightness was observed in a temperature range from $-100°C$ to $+50°C$. This fact suggests that the mechanism responsible for electroluminescence does not depend on thermal activation. A.

535.39–32

777. Apparatus for the measurement of reflecting power in the vacuum ultraviolet. S. ROBIN AND B. VODAR. Letter in *J. Phys. Radium*, **13**, 492 (*Oct.*, 1952) *In French.*

This apparatus is used in conjunction with a monochromator for the vacuum ultraviolet. Measurements can be made of transmission and reflection coefficients for 18° and 45° incidence. Other special features include a reference beam for monitoring the incident intensity and arrangements to make measurements on evaporated layers produced *in situ*. Photomultipliers with sodium salicylate fluorescent screens are used as detectors. D. G. AVERY

535.39–32

778. Photometric measurement of optical constants in the Schumann region of the ultraviolet. S. ROBIN. Letter in *J. Phys. Radium*, **13**, 493 (*Oct.*, 1952) *In French.*

A method is described using measurements of the reflection coefficients of a substance, at normal

incidence and at 45° for light polarized || and ⊥ to the plane of incidence. The latter measurements are obtained using two mirrors of the substance whose planes can be turned relative to one another through 90°, and total polarization of the incident light is not required. Hence the method is valuable in spectral regions where polarizers are not readily obtainable, e.g. the Schumann region. D. G. AVERY

535.417 : 531.715.1

779. Measurement of thickness of microscopic objects using three-beam interference. E. MENZEL. Note in *Naturwissenschaften*, **39**, *No.* 17, 398–9 (1952) *In German.*

A microscope modification of a technique formerly described, wherein the thickness of a thin object is obtained from change in localization of fringes produced by three slits. A microscopic reduced image of the three slits is projected on to the small object on the microscope stage and by observing changes in localization of fringes with beams going through and missing the microscopic object, thicknesses can be measured as small as 100 Å units. S. TOLANSKY

535.417 : 535.515 : 535.822.9

780. Interference by double refraction with white light. New methods for the observation of transparent objects. M. FRANÇON. *J. Phys. Radium*, **13** (*Suppl. No.* 7–8–9) 99A–104A (*July–Aug.–Sept.*, 1952) *In French.*

Different methods are described for the examination of transparent objects. These include interference methods in which the object investigated is rendered visible by a polariscope method. The technique which is described could be applied to study the variations in optical path produced either by aberrations or changes of refractive index of liquids or solids. It can be applied to standard microscopy without changing its microscopic elements and can be used both in transmission and reflection in white light. The principal advantage of the technique is the simplicity. There are no adjusting difficulties as distinct from the adjustments required in interferometry. The precision of the method is discussed in detail. No parasitical fringes are formed. The technique uses colours for which the eye is extremely sensitive. In the limit the method is as sensitive as phase contrast. S. TOLANSKY

535.421

781. Remarks on the theory of grating anomalies. V. TWERSKY. Letter in *J. Opt. Soc. Amer.*, **42**, 855–6 (*Nov.*, 1952).

The outline is given of a new theoretical approach which views the anomalies as shortcomings of the single scattering approximation usually employed. The exact solution of the multiple scattering predicts the effects seen in optical reflection gratings. Similar effects should occur with microwave transmission gratings and in acoustics. R. W. FISH

535.43

782. Light scattering by pure [solid] polystyrene. F. BUECHE. Letter in *J. appl. Phys.*, **23**, 1280–1 (*Nov.*, 1952).

Although impure specimens show enhanced scattering, suitable heat treatment reduces the scattered intensity to about $\frac{1}{3}$, to correspond with values obtained from solution measurements. G. F. LOTHIAN

535.43 : 548.7

783. Experimental results of the study of the scattering of light by a single crystal of sodium chloride. L. TAUREL. *C.R. Acad. Sci.* [*Paris*] **234**, 2530–2 (*June* 23, 1952) *In French.*

For the incident beam at angles α of 0°, 22° and 45° to OX in the plane XOY and the scattered beam at 90° in the same plane. I (with electrical field || OZ) and i (with field ⊥ OZ) increase more than theoretically expected from $\alpha = 0°$ to 45°. This is due to cracks in the shape of thin plates of length 1800 Å. See also Abstr. 8099 (1952). C. TURNER

535.435 : 541.64

784. Light scattering of multicomponent macromolecular systems. J. J. BLUM AND M. F. MORALES. Letter in *J. chem. Phys.*, **20**, 1822 (*Nov.*, 1952).

The treatment of Zimm [Abstr. 2456 (1949)] is used to develop an expression for $I(\theta)$, which will be useful in measurements on muscle proteins. G. F. LOTHIAN

535.6

785. Light sources and colours: physical and practical aspects. F. TARNAY AND E. BARTHÈS. *Bull. Soc. Franç. Elect.* (*Sér.* 7) **2**, 574–94 (*Oct.*, 1952) *In French.*

In the first part F. Tarnay describes the colour properties of daylight and of various artificial lights used as standards in colorimetry and shows how sources with very different spectral distributions may have the same colour, although when these sources illuminate differently coloured surfaces the reflected lights have no longer the same colour specification. The sensitivity of the eye to colour is discussed and finally the requirements of a source to be used for colour matching are described. The second part, by E. Barthès, is concerned with colour rendering and discusses the spectral distribution and level of the illumination required. It is concluded that fluorescent light, under proper conditions, can be used for judging colours correctly, except under certain especially exacting conditions which are, in general, confined to the laboratory. J. W. T. WALSH

535.681 : 628.972

786. Colour and lighting. III. G. T. WINCH AND B. M. YOUNG. *G.E.C. J.*, **19**, 203–11 (*Oct.*, 1952).

A continuation of previous work on colour adaptation [Abstr. 6157 (1951)], using the binocular matching method. It is found that the change from tungsten to daylight illumination or vice versa is almost completely compensated in the case of white or blue objects but only partially for reddish objects. For the change of illuminant from daylight to fluorescent mellow, compensation is only partial in all cases. Experiments were also made on the appearance of certain foodstuffs. The effect of coloured decorations in altering the colour appearance of objects was investigated and found not to be negligible. Other factors influencing subjective colour impressions are discussed. J. W. T. WALSH (R)

535.7 : 612.84

Physiological optics. *See Abstr.* 1305-11

535.822.5 : 578 : 621.397.9

787. Ultraviolet television microscopy. V. K. Zworykin, L. E. Flory and R. E. Shrader. *Electronics*, **25**, 150–2 (*Sept.*, 1952).

Many biological substances which are almost colourless, and hence give poor contrast under the ordinary microscope, exhibit highly selective absorption in the u.v. region. A miniature television camera, fitted with an ultraviolet sensitive pick-up tube, is used to provide a video signal, which with suitable scanning and synchronizing circuits, will give a picture on a c.r.t. The wavelength which gives the best contrast with a given specimen is selected by sweeping a spectrum over a slit below the condensing lens of the microscope. The illuminator is an Hg lamp. An arrangement for obtaining a colour picture representative of the u.v. absorption characteristics is described. W. G. STRIPP (R)

535.822.9

788. The contrast effect of thick objects in phase microscopy. R. Barer. Note in *Naturwissenschaften*, **39**, *No.* 18, 427 (1952).

Previous results [Abstr. 5060 (1952)] are discussed. Difficulties in interpreting phase-contrast images may arise from refraction and reflection effects or from the imperfect separation of the object and comparison beams. Birefringent objects may require the use of plane polarized light. 13 references. R. W. FISH

535.822.9

789. Phase microscopy (principles and applications). A. H. Bennett, H. Jupnill, H. Osterberg and O. W. Richards. *London, Chapman & Hall*, 320 *pp.* Review in *Brit. J. appl. Phys.*, **3**, 365 (*Nov.*, 1952).

535.826.3 : 539.27

790. A cantilever microtome for precision sectioning in electron and light microscopy. G. G. Cocks and C. M. Schwartz. *Rev. sci. Instrum.*, **23**, 615–18 (*Nov.*, 1952).

A microtome has been built incorporating the principle of deflection of a cantilever to provide the highly reproducible motion necessary in cutting thin sections for electron microscopy. The prototype has been tested, and representative electron micrographs are shown. Alternative designs are discussed. Certain advantages are realized by the application of this principle. A simple construction with a minimum of precise machining readily provides an accurately reproducible motion. No sliding ways or lubricated bearings are needed. The effects of vibration, static friction, and thermal expansion are minimized. The instrument is easily adapted for cutting thin sections for light microscopy. A.

535.83 : 522.29

Optical problems of the Palomar Observatory. *See Abstr.* 579

535.89 : 535.375.5

791. A source unit for Raman spectroscopy. J. W. Kemp, J. L. Jones and R. W. Durkee. *J. Opt. Soc. Amer.*, **42**, 811–14 (*Nov.*, 1952).

A Raman source has been constructed and tested using a helical mercury lamp of the "Toronto" type. Studies of intensity *v.* mercury pool condenser temperature and *v.* lamp current indicate that a condition of maximum stability can be obtained by proper choice of current and condenser temperature. To aid in starting and to increase the efficiency of the lamp, a special lamphouse has been designed. The complete unit then provides stable, high intensity, mercury radiation at 4358 Å. Ratios of 4347 Å, 4339 Å, and background to 4358 Å are approximately 0·008, 0·002 and 0·0005, respectively. Background was measured at 4369 Å (45 cm^{-1} shift) and represents a maximum possible value. A.

HEAT 536

536.1

792. On the generalization of the thermal potential. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 1–2, 81–8 (1952) *In French.*

The idea of thermal potential is generalized by combining it with that of potential energy. F. E. HOARE

536.2

793. Film boiling termination mechanism. J. W. Marx and B. I. Davis. *J. appl. Phys.*, **23**, 1354–7 (*Dec.*, 1952).

It is suggested that free molecule heat conduction provides the critical energy transfer that just precedes the collapse of the vapour blanket in the film boiling process. An expression for the extreme possible values of the heat transfer coefficient, as a function of pressure, is derived for solid-boiling liquid systems and numerically evaluated for water. The wetting temperature is given in terms of measurable parameters of the system, and experiments are suggested. A.

536.2 : 536.66

794. On the theory of thermal transfer in reacting fluid mixtures. J. Meixner. *Z. Naturforsch.*, **7a**, 553–9 (*Aug.*, 1952) *In German.*

The Nernst relation for thermal transfer in a dissociating gas, where the diffusion of the dissociation energy is considered, is here generalized to an arbitrary fluid system in which a chemical reaction is possible. The influence of thermo-diffusion, the diffusion thermo-effect and the reaction velocity on the thermal transfer is estimated. F. E. HOARE

536.21 : 536.631

795. A rapid method of determining thermal characteristics of poor heat conductors. V. S. Volkenshteĭn. *Zh. tekh. Fiz.*, **22**, *No.* 6, 1043–9 (1952) *In Russian.*

Describes a method enabling the heat conductivity coefficient λ, temperature conductivity coefficient a, and the volume heat capacity cy to be determined simultaneously, the actual measurement lasting 2–3 min. A plane-parallel plate of the material tested is placed between a flat constant-temperature heater and a heat insulator with known thermal characteristics. The temperature at the boundary material-insulator is measured continuously by means of a thermo-couple. Formulae for evaluating the three thermal characteristics are derived, and their experimental determination for a synthetic resin sample is described in detail. F. LACHMAN

536.21 : 548

796. Investigation of the influence of atomic admixtures on the thermal conductivity of the crystal lattice. E. D. DEVYATKOVA AND L. S. STILBANS. *Zh. tekh. Fiz.*, **22**, *No.* 6, 968–72 (1952) *In Russian.*

The results of the experiments lead to the following conclusions: (1) the disruptions of the KCl lattice produced by colouring (at concentrations from 0·5 to 5×10^{18} of the colour centres representing $1\cdot5\times10^{-3}$ to $1\cdot5\times10^{-2}$% of the number of K and Cl ions) increase the thermal resistance of the crystal by a few %; (2) the variation of the thermal resistance is of the same order of magnitude for the 3 temperature ranges investigated (450–710°C, 25°–73° to −175°C); (3) at room temperature, where the accuracy of the measurements is within ±1%, a definite variation law of the thermal resistance as function of the coloured colour centres was found and may be represented by a smooth curve. At lower temperatures the accuracy obtained is only within ±5% and a quantitative relationship between thermal resistance and the number of lattice disruptions could not be established.

B. F. KRAUS

536.24

797. Introduction to the transfer of heat and mass. E. R. G. ECKERT. *New York, London; McGraw-Hill* (1950) xiii + 284 *pp.* Review in *Proc. Phys. Soc.* [*London*] *A*, **65**, 864 (*Oct.*, 1952).

536.24

798. Temperature rise in a heat-producing solid behind a surface defect. W. KARUSH AND G. YOUNG. *J. appl. Phys.*, **23**, 1191–3 (*Nov.*, 1952).

Simple expressions are obtained, in certain cases, for the temperature increase in a heat-producing body when the normal heat flow from the body is blocked by defective cooling on portions of the surface of the body. Defective areas in the shape of long strips and round spots are considered. A.

536.421.1 : 548.736.5

799. A new method of melting ferromagnetic semiconductors $BaFe_{18}O_{27}$, a new kind of ferromagnetic crystal with high crystal anisotropy. H. P. J. WIJN. Letter in *Nature* [*London*] **170**, 707–8 (*Oct.* 25, 1952).

A method is described for the preparation of ferromagnetic oxides by melting together in a h.f. furnace the appropriate mixture of magnetite and metal oxide. The initial melting is carried out in atmosphere of N, which is later replaced by the required high pressure of O. Slow cooling from this melt produces disk-shaped crystals. From a melt of Fe_3O_4 and $BaCO_3$ in oxygen a new crystal of composition $BaFe_{18}O_{27}$ was formed [see Abstr. 1263 (1953)]. D. G. AVERY

536.424

800. A new transition of ammonium dichromate crystals. J. JAFFRAY. Letter in *J. Phys. Radium*, **13**, 430 (*July–Aug.–Sept.*, 1952) *In French.*

A transition point at *c.* −120°C has been detected by means of differential thermal analysis and determined more precisely by measurements of specific heat. F. LACHMAN

536.424 : 539.16.08

801. Proof of metallurgical transformations with the needle counter. E. HOUDLEMONT AND O. RUDIGER. Note in *Naturwissenschaften*, **39**, *No.* 17, 399–400 (1952) *In German.*

Shows that metallurgical changes, such as the α–γ-phase change in iron, are accompanied by sudden changes in the number of counts per minute registered on a counter immersed in an argon atmosphere over a heated clean wire of the metal under observation. Re-crystallization is better studied by resistance changes. Hysteresis phenomena are observed as the metal is heated and cooled through the transformation temperature. A. H. W. BECK

536.453

802. The semi-industrial solar furnace of the Mont-Louis laboratory (Eastern Pyrenees). F. TROMBE. *C.R. Acad. Sci.* [*Paris*] **235**, 704–5 (*Oct.* 6, 1952) *In French.*

The large paraboloidal solar furnace can develop power equivalent to 75 kW. Oil-operated mechanism turns the furnace about two perpendicular axes and a photoelectric cell circuit keeps it pointing to the sun. The maximum temperature is estimated to be 3400°C, but the working temperature is 2500°–2600°C. A melt of 60 kg of iron per hour is estimated. E. H. DOCK

536.461

803. Observations on the Bunsen burner. W. JOST. *Naturwissenschaften*, **39**, *No.* 18, 418–24 (1952) *In German.*

A review of investigations on the shape and structure of the Bunsen flame, comprising theories of the general and detailed structure of the burning zone, and experimental observations on polyhedral flames, soot-formation and detached oscillatory flames. Original photographs of these phenomena (including shadow and schlieren photographs) are reproduced, and a bibliography of 18 references is appended.

A. SCHOFIELD

536.48

804. Heat pulses in He II below 1°K. C. J. GORTER. Letter in *Phys. Rev.*, **88**, 681 (*Nov.* 1, 1952).

Attention is drawn to the high attenuation of these pulses and it is suggested that they might rather be considered as a normal transmission of heat pulses in a medium of a certain specific heat and thermal conductivity, the mean free path of the phonons being determined by the width of the vessel.

H. LONDON

536.48 : 536.23 : 541.183

805. Heat conduction and isotherms of adsorbed helium on silica gel. D. WHITE, CHIEN CHOU AND H. L. JOHNSTON. Letter in *J. chem. Phys.*, **20**, 1819–20 (*Nov.*, 1952).

The heat conductivity κ for helium of a tube packed with silica gel was measured. κ became anomalously high only when $p/p_s > 0\cdot97$ (p = pressure, p_s = saturated vapour pressure, of helium). The adsorption isotherm of He on the silica gel when plotted against p/p_s was identical above and below the λ-point, and was of the Langmuir form, denoting that the adsorbed layer does not exceed one molecule in thickness except perhaps near p/p_s. Absence of multilayer formation is said to correspond to unusually high binding forces, so accounting for the fact that superfluidity does not occur until capillary condensation has filled the capillaries. S. J. GREGG

536.48 : 536.24

806. Heat exchange between a solid body and helium II. I. M. KHALATNIKOV. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 687–704 (1952) *In Russian.*

Three processes causing heat exchange are considered theoretically: radiation of sound from the vibrations of the solid, and collisions of phonons and rotons at the boundary. It is shown that the first of these is dominant and leads to a temperature difference between a solid and the surrounding helium II which is proportional to the heat flow and inversely proportional to T^3; this agrees qualitatively with Kapitza's observations, though the observed difference is rather smaller than the calculations predict. The passage of second sound through a thin metallic foil is also discussed. D. SHOENBERG

536.483

807. Helium liquefier. S. C. COLLINS. *Science*, **116**, 289–94 (*Sept.* 19, 1952).

A description, with diagrams and photographs, of the large liquefaction plant recently completed in the Cryogenic Engineering Laboratory of M.I.T. The cooling is effected by an expansion engine, and the heat exchangers are of the Hampson type. The liquefier produces 25–32 litres of He per hr if liquid N_2 is used, and 10 litres without. R. B. DINGLE

536.483 : 532.51

808. Experimental investigation of the Ranque vortex tube. K. SCHMIDT. *Z. Naturforsch.*, **7a**, 480–6 (*July*, 1952) *In German.*

The results of measurements of the pressure and temperature distribution in a vortex tube are given and compared with the explanation of the Ranque effect given by Schultz-Grurow. It is shown that the theoretical explanation agrees with the conclusions drawn from the experiments. F. E. HOARE

536.5

809. The concept of temperature. A. R. MILLER. *Amer. J. Phys.*, **20**, 488–91 (*Nov.*, 1952).

The logical deduction of the existence of the concept of temperature from the laws of thermal equilibrium is examined. The mathematical proof that the relation given by Carathéodory, in his phenomenological discussion of the laws of thermodynamics, is a necessary and sufficient condition is supplied, thus refuting criticism that has been made of his work. The descriptive account sometimes given from a consideration of corresponding isotherms is also examined. It is shown how this qualitative idea can be put into analytical form. A.

536.5

810. Remarks on "The concept of temperature" by A. R. Miller. H. C. WOLFE AND M. W. ZEMANSKY. *Amer. J. Phys.*, **20**, 492 (*Nov.*, 1952).

The authors compare Miller's paper (preceding abstract) with their own of 1941 on the same subject.

536.521 : 536.58

811. Rotor temperature measurement and control in the ultracentrifuge. D. F. WAUGH AND D. A. YPHANTIS. *Rev. sci. Instrum.*, **23**, 609–14 (*Nov.*, 1952).

Moving rotor temperatures may be measured with precision of $\pm 0{\cdot}03$°C and an accuracy of $0{\cdot}1$°C in a vacuum centrifuge. The method does not use physical contact with the rotor but utilizes the i.r. radiation from the rotor. A reference temperature is maintained in a mass of metal (reference block) placed near and shielding the base of the rotor. A Cu disk, shielded also by the reference block, assumes a temperature between rotor and reference block temperatures through radiation exchange. The various temperatures and temperature differentials are determined by Cu-constantan thermocouples. Heat conduction through thermojunction leads and Cu disk supports, and radiation exchange between Cu disk and reference block have been minimized, the Cu disk maintaining a temperature $0{\cdot}72$ of that between reference block and rotor. On acceleration the rotor cools, the opposite effect occurring during deceleration. Such changes are shown to be due to the adiabatic changes concomitant with the production or release of stress in the rotor. At 60 000 r.p.m. a change of $-0{\cdot}9$°C is observed on acceleration. On correction for kinetic heating this becomes $-1{\cdot}0$°C. Such changes have not generally been taken into account. By installing a chamber heating coil in addition to refrigeration, the moving rotor temperature may be kept to within $\pm 0{\cdot}05$°C of a chosen temperature for indefinite periods. A.

536.531

812. Influence of pressure on the resistivity of a thermistor. P. TAVERNIER AND P. PRACHE. *J. Phys. Radium*, **13**, 423–6 (*July–Aug.–Sept.*, 1952) *In French.*

The variation in resistance, expressed as the fractional change $\Delta R/R_0$, of a thermistor kept at a constant temperature and subjected to various pressures P up to 5000 kg cm^{-2}, is represented by the equation $\Delta R/R_0 = -4{\cdot}6\times10^{-6}P$. This relation holds almost exactly for any given temperature in the range 30–70°C. The themistor-controlled thermostatic bath used in the experiments is described.

C. A. HOGARTH

536.532 : 536.422.1

813. Behaviour of platinum/platinum-rhodium thermocouples at high temperatures. M. K. MCQUILLAN. Letter in *J. sci. Instrum.*, **29**, 301–2 (*Sept.*, 1952).

Recent notes [Abstr. 956, 4321 (1952)] are re-examined and it is concluded that apparent differences may be explicable in terms of the vapour pressure/temperature curves of Pt and Rh or that they may lie in the chemical analysis. E. H. DOCK

536.587 : 621.316.7

814. Control by a continuous action thermostat. Y. DOUCET AND P. CHAUCHEFOIN. *J. Phys. Radium*, **13** (*Suppl. No.* 7–8–9) 131A–134A (*July–Aug.–Sept.*, 1952) *In French.*

Temperature oscillations arising with a simple on-off thermostat are shown to consist of exponential components which, to a first approximation, are linear. Requirements for accurate control are deduced from the analysis and it is suggested that a thermistor connected into a bridge circuit supplies many of these. A suitable amplifier circuit is described and the sensitivity of the system is considered.

E. H. DOCK

536.631

815. The specific heat of lead in the temperature range 1°K to 75°K. M. Horowitz, A. A. Silvidi, S. F. Malaker and J. G. Daunt. *Phys. Rev.*, **88**, 1182–6 (*Dec.* 1, 1952).

The specific heat of pure Pb in the temperature range 1°K to 75°K has been measured calorimetrically, both in the normal and superconductive states. The measurements were made using a useful semi-automatic recording system. It was found that at the lowest temperatures (1°K to 4°K) the lattice specific heat of Pb in the normal state was a T^3 function, with a Debye $\theta = 96{\cdot}3$°K. It was found that the variation of θ with temperature over the whole range of temperature employed confirmed the theoretical computations made by Leighton for f.c.c. lattices. The normal electronic specific heat was found to be $7{\cdot}48\times10^{-4}\,T$ cal/mole-deg, in good agreement with results from magnetic measurements on superconducting Pb. The measured value of the electronic specific heat of the superconducting state was $C_{el,s} = 5\times10^{-5}T^3$ cal/mole-deg, in the temperature range 1°K to 4°K; this result was also in agreement with the magnetic measurements. A.

536.631 : 541.113

816. An anomaly in the low temperature atomic heat of silver. P. H. Keesom and N. Pearlman. Letter in *Phys. Rev.*, **88**, 140 (*Oct.* 1, 1952).

Measurements on a single crystal are reported and compared with those on polycrystalline material due to Keesom and Kok (1932, 1933). A plot of C_v/T against T^2 revealed that both sets of measurements can be represented by a law of the form $C_v = aT^3 + bT$, but that a and b change from $1{\cdot}619\times10^{-4}$ and $6{\cdot}45\times10^{-4}$ below 2·2°K to $1{\cdot}598\times10^{-4}$ and $7{\cdot}82\times10^{-4}$ above 2·5°K.

P. T. LANDSBERG

536.631 : 541.113

817. The atomic heat of silicon below 100°K. N. Pearlman and P. H. Keesom. *Phys. Rev.*, **88**, 398–405 (*Oct.* 15, 1952).

The atomic heat of Si containing less than 0·01% *P*-type impurities has been measured between 1°K and 100°K. Below 5°K, the atomic heat can be represented by the sum of a cubic term with Debye $\theta = 658$°K, and a linear term equal to that of a highly degenerate "hole gas" with concentration about 10^{18} cm^{-3}. This is also the hole concentration calculated from Hall constant measurements on this material. The Debye θ calculated from elastic constants is 653°K, using a simplified procedure based on the Hopf–Lechner method. The atomic heat is in reasonable agreement with measurements of Nernst and Schwers above 20°K, and of Anderson above 60°K. Above 5°K, θ decreases to a minimum of 456°K at $T = 40$°K and then rises to 580°K at $T = 100$°K. The specific heat of glyptal lacquer, which was used to secure the heater and thermometer wires to the samples, was also measured. Below 15°K, it can be represented by $c = 2{\cdot}2\times10^{-4}T^2$ joules/g deg, and a table is given of values above this temperature. A.

536.65 : 536.7

818. Effect of pressure on the melting point of Teflon tetrafluoroethylene resin. P. L. McGeer and H. C. Duus. Letter in *J. chem. Phys.*, **20**, 1813 (*Nov.*, 1952).

A piezometer was used to follow specific volume-temperature curves of the coagulated dispersion resin at three pressures. The relation between melting point (T_m°K) and pressure (P atm.) is $T_m = a + bP$, where $a = 597$, $b = 0{\cdot}154$. From the observations the latent heat was calculated using Clapeyron's equation. The entropy of fusion was found to be lower at 207 atm. than at 69 atm. The effects of temperature and pressure on the entropy of fusion are considered and shown to be too small to account for this change which is attributed to a change in the degree of crystallinity between the time the specimen was first melted at 69 atm. and when it was remelted at 207 atm. F. E. HOARE

THERMODYNAMICS 536.7/.8

536·7

819. Advances in thermodynamics. J. R. Partington. *Nature* [*London*] **170**, 730–2 (*Nov.* 1, 1952).

A review article tracing the chronological development of thermodynamics. Several points of interest concerning the introduction of the different thermodynamic functions are dealt with and the evolution of the Nernst heat theorem is outlined. The article concludes with a paragraph on the thermodynamics of irreversible processes and a review of four recent books on thermodynamics. F. E. HOARE

536.7

820. On the equivalence of the principle of superposition and Onsager's principle. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 1–2, 89–101 (1952) *In French.*

The agreement between the author's theory and that of Onsager is established. The work of Tolman and Fine [Abstr. 2820 (1948)] is then analysed and shown to depend upon the principle of superposition. F. E. HOARE

536.71 : 533.75

821. On a new thermal equation of state for gases and fluids. J. Himpan. Note in *Naturwissenschaften*, **39**, *No.* 18, 426 (1952) *In French.*

See Abstr. 3554–5, 8148 (1952). A modified equation is applied to water and isothermals are plotted (pv/p). The agreement with measurements by Kennedy and Hutte for liquid and vapour states is very satisfactory. F. E. HOARE

536.71 : 535.343.3·14 : 539.132

822. Heat capacity, gas imperfection, infrared spectra, and internal rotation barriers of ethyl alcohol. G. M. Barrow. *J. chem. Phys.*, **20**, 1739–44 (*Nov.*, 1952).

The vapour heat capacities of ethyl alcohol have been measured, as a function of pressure, at 368, 422, and 476°K. From the variation of the heat capacity with pressure, together with vapour densities calculated by the Clapeyron equation, an equation of state for ethyl alcohol has been obtained. This equation has been used to extrapolate the measured heat capacities to the ideal gas state and likewise to

correct the observed entropy. The infrared spectra of vapour C_2H_5OH, C_2H_5OD and liquid C_2H_5OD are presented and a vibrational assignment is obtained which is sufficiently reliable for the statistical calculation of the thermodynamic properties. Comparison of the observed and statistically calculated heat capacities and entropies shows that, with a barrier to internal rotation of the CH_3 group of 3000 calories, the rotation of the OH group is hindered by a barrier between 0 and 1200 calories. Most satisfactory agreement is obtained for CH_3 and OH barriers of 3300 and 800 calories respectively. Furthermore, comparison of the observed and calculated equilibrium constants for the reaction $C_2H_4(g) + H_2O(g) \rightleftarrows C_2H_5OH(g)$ supports the selection of fundamental frequencies and internal rotation barriers. A.

536.75

823. On the states of minimum entropy production in continuous systems. P. MAZUR. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 1–2, 182–95 (1952) *In French.*

The object of the paper is to show how Prigogine's theorem on the states of minimum entropy production may be extended to the case of continuous systems. This generalization enables the stability of stationary states to be established very easily. F. E. HOARE

536.75 : 536.666

824. Heats, free energies, and entropies in liquid ammonia. W. L. JOLLY. *Chem. Rev.*, **50**, 351–61 (*June*, 1952).

Contains a table of (1) heats of formation, (2) free energies of formation at 33°C, (3) entropies, and (4) differences between hydration and ammonation energies for 22 ions and compounds (including H_2O, NH_3, and e^-), calculated from the available experimental data, using certain assumptions. The absolute ammonation energy of e^- is 39 kcal/mole. The free energy for $e^-(am) + NH_3 = \frac{1}{2}H_2 + NH_2^-(am)$ is −4 kcal/mole. An addendum contains another table giving data for 8 ions, based on recent research. It appears that the notation $\frac{1}{2}e_2^{--}(am)$ should probably replace the notation $e^-(am)$, as the existence of unpaired electrons at moderate concentrations seems unjustified. F. LACHMAN

ELECTRICITY 537

ELECTROSTATICS . DIELECTRICS 537.2

537.213 : 616–073

825. Electric potential produced by two point current sources in a homogeneous conducting sphere. E. FRANK. *J. appl. Phys.*, **23**, 1225–8 (*Nov.*, 1952).

The electric potential produced by positive and negative point current sources located in a homogeneous conducting sphere, a problem of interest in the field of electrocardiography, is obtained for arbitrary source locations and separations. Certain special cases of the general solution that are of particular value in both experimental and theoretical electrocardiographic research are also presented. A.

537.221

826. A direct comparison of the Kelvin and electron beam methods of contact potential measurement. P. A. ANDERSON. *Phys. Rev.*, **88**, 655–8 (*Nov.* 1, 1952).

Comparison of contact potential values determined for a given pair of surfaces by (1) the Kelvin method which is insensitive to patch fields, and (2) the electron beam method which is, according to patch theory, sensitive to these fields, offers a means of testing the validity of the theory and of determining the extent to which patch effects influence electron beam measurements. A technique for carrying out such comparative measurements in a single sealed-off tube is described. Barium and silver are selected for the study because of the known reproducibility and long-period constancy of their work functions. The measured surfaces are prepared by fractional distillation following intensive outgassing and the technique allows repetitive checking through renewal of these surfaces. Special attention is given to the conditions required for satisfactory Kelvin measurements in all-glass, sealed-off systems. The contact differences of potential found for silver films deposited on a tantalum substrate and barium films laid down on the silver were $1{\cdot}79 \pm 0{\cdot}03$ V by the electron beam method and $1{\cdot}78 \pm 0{\cdot}01$ V by the Kelvin method. This result is discussed from the standpoint of theoretical expressions for the Kelvin and *e*-beam values, the latter generalized to the case of an arbitrary number of patch types and arbitrary coverage factors. It is concluded (1) that crystal growth mechanisms are capable of reducing patch effects to insignificance under favourable conditions, but that (2) the most likely explanation of the present results is failure of the normal energy assumption and hence of the patch theory based on it to hold for the retarding field, slow electron case. It is suggested that an electron optical treatment of the patch field region may supply a more satisfactory theory. A.

537.226

827. The dielectric polarization of polar liquids. T. WATANABE AND T. TANAKA. *Mem. Fac. Sci. Kyūsyū Univ. B*, **1**, *No.* 2, 43–9 (*March*, 1952).

A general statistical-mechanical treatment of polar interactions which gives the dielectric constant in a power series in $1/T$. The treatment reduces to the Onsager or to the Van Vleck formulae with appropriate simplifying assumptions. D. H. WHIFFEN

537.226 : 621.315.61

828. Digest of the literature of dielectrics. Volume XV—1951. Edited by H. THURNAUER AND S. ROBERTS. *Publ. Nat. Res. Coun. Nat. Acad. Sci. U.S.A.*, *No.* 231, 203 *pp.* (*Sept.* 15, 1952).

This annual volume is prepared by the Committee on Digest of Literature of the Conference on Electrical Insulation. *Trends in research and development in dielectrics—1951* (S. Roberts) 3 pp. *Molecular and ionic interactions in dielectrics* (J. D. Hoffman and F. E. Luborsky) 25 pp., 115 refs. *Instrumentation and measurements* (R. F. Field and R. A. Soderman) 11 pp., 79 refs. *The breakdown of dielectrics* (J. K. Bragg, R. W. Crowe and A. H. Sharbaugh) 11 pp., 56 refs. *Semiconductors* (A. E. Middleton and K. E.

Cochran) 50 pp., 452 refs. *Barium titanate and related subjects* (R. J. Dew, Jr) 13 pp., 50 refs. *Ceramic insulation* (M. D. Beals and A. Linz, Jr) 8 pp., 60 refs. *Insulating liquids* (J. E. Gibbons and W. C. Witham) 11 pp., 55 refs. *Insulating films* (H. A. Birdsall) 10 pp., 45 refs. *Synthetic plastic insulation* (T. Hazen) 59 pp., 356 refs. *Bibliography on rubber insulation* (F. W. Boggs) 4 pp., 28 refs.

537.226.2

829. The construction of a liquid dielectrics test cell. S. Baxter and H. A. Vodden. Note in *J. sci. Instrum.*, **29**, 379–81 (*Nov.*, 1952).

Description of a simplified concentric cylindrical test cell for loss angle and d.c. conductivity measurements on viscous fluids, between −30° to 120°C. The cell is easily constructed, assembled, and cleaned between measurements. J. H. MASON

537.226.2 : 621.315.612.4

830. A new dielectric material. L. Nicolini. Letter in *Nature* [*London*] **170,** 938 (*Nov.* 29, 1952).

A form of TiO_2 prepared at 1400°C, and showing the normal rutile Debye–Scherrer pattern, has been found to have a permittivity $\varepsilon > 10^4$ at 10 c/s, 2×10^3 at about 2×10^4 c/s, and about 10^2 at 10^6–10^7 c/s. The loss tangent $\tan\delta$ rises to a peak of 3·2 at about 2×10^4 c/s. F. F. ROBERTS

537.226.2

831. The complex dielectric constant at 9500 Mc/s of some phosphates as a function of temperature. S. Le Montagner, J. Le Bot and Y. Allain. *C.R. Acad. Sci.* [*Paris*] **235,** 1199–1201 (*Nov.* 17, 1952) *In French.*

Curves of ε' and ε'' from 80° to 290°K are given for KH_2PO_4 (Curie pt. 122°K); K_2HPO_4; K_3PO_4; $(NH_4)H_2PO_4$ (transition pt. 149°K with extremely sharp peak in ε'' within 1°); $(NH_4)_2HPO_4$; $(NH_4)_3PO_4$ (transition pt. 262°K); NaH_2PO_4; Na_2HPO_4; Na_3PO_4 (transition range 110–180°K). D. H. WHIFFEN

537.226.2 : 537.228.1

832. Electromechanical properties of $BaTiO_3$ compositions showing substantial shifts in phase transition points. D. A. Berlincourt and F. Kulcsar. *J. Acoust. Soc. Amer.*, **24,** 709–13 (*Nov.*, 1952).

Incorporation of $CaTiO_3$ or Y_2O_3 into $BaTiO_3$ ceramics causes a downward shift of the second transition point, resulting in substantial improvement of temperature stability in the normal operating range. Dielectric and electromechanical properties of $BaTiO_3$ ceramics containing $CaTiO_3$, Y_2O_3, and $PbTiO_3$ are shown from −40° to +120°C. The composition containing 5 weight % $CaTiO_3$ combines high piezoelectric response with low temperature-dependence of operating characteristics. A.

537.226.2 : 537.228.1 : 539.32 : 548.0

The dielectric properties of $ND_4D_2PO_4$ (deuterated ADP). *See Abstr.* 1236

537.226.2 : 538.569.3 : 621.396.11

833. Electrical properties of sea water. J. A. Saxton and J. A. Lane. *Wireless Engr*, **29,** 269–75 (*Oct.*, 1952).

The results of recent measurements by the authors of the dielectric properties of aqueous sodium chloride solutions at frequencies between 9400 Mc/s and 48 000 Mc/s are summarized, and then applied to the calculation of the electrical properties of sea water at various temperatures and any radio frequency. The results indicate that sea water has a static dielectric constant of about 75 and 69 at 0°C and 20°C respectively, compared with values of 88 and 80 for pure water at these temperatures. The reflection coefficient of sea water is given as a function of the angle of incidence at frequencies between 30 Mc/s and 30 000 Mc/s, and it is shown how the dipolar and ionic conductivities govern the attenuation of pure, fresh and sea water at radio frequencies. A.

537.226.2 : 666

834. Dependence of the dielectric constant and the loss angle of silicate glasses on their composition. A. A. Appen and R. I. Bresker. *Zh. tekh. Fiz.*, **22,** *No.* 6, 946–54 (1952) *In Russian.*

The silicate glasses investigated were specially produced and tested at $4\cdot5\times10^8$ c/s and room temperature. The relationships observed were established generally and qualitatively. They correspond in principle to those of boron glasses. For a number of oxide components approximate values of the partial diel. const. were found, enabling the diel. const. of boron-less silicate glasses to be calculated from their composition on the additivity law, correct within ±1·5–2·0%. This applies to SiO_2 contents 50–84%, the other components being in concentrations of 0–25%. B. F. KRAUS

537.228.1

835. Piezoelectric resonance of quartz up to 5000 atm. J. P. Pérez and P. Johannin. Letter in *J. Phys. Radium*, **13,** 428–9 (*July–Aug.–Sept.*, 1952) *In French.*

No appreciable diminution in the sharpness of resonance of quartz was observed under hydrostatic pressures up to 5000 atm. in petroleum ether. A 3·265 Mc/s Y-cut plate, in transverse vibration parallel to the X-axis, experienced a linear frequency change with a coeff. $\Delta f/f\Delta p$ of $-3\cdot1\times10^{-6}$ cm²/kg. The magnitude of this change is attributed largely to a change in the appropriate elastic modulus. H. J. H. STARKS

537.228.1 : 537.226.2 : 539.32 : 548.0

The piezoelectric properties of $ND_4D_2PO_4$ (deuterated ADP). *See Abstr.* 1236

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.1 : 537.312.6 : 538.63

836. Thermomagnetic and galvanomagnetic effects [in metals]. J. E. Verschaffelt. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38,** *No.* 3, 267–86 (1952) *In French.*

Gives a general treatment of the behaviour of metals under the influence of electrical and magnetic fields and of a temperature gradient and gives a critical discussion of related work by Callen [Abstr. 2841 (1948)] on the application of Onsager's reciprocity relations. E. P. WOHLFARTH

537.311.3 : 539.893

837. The [electrical] resistance of 72 elements, alloys and compounds to 100,000 kg/cm². P. W. BRIDGMAN. *Proc. Amer. Acad. Arts Sci.*, **81**, 169–251 (*March*, 1952).

A detailed account of experimental technique and results. The technique differs from that used previously to measure resistance to 30 000 and volume changes to 100 000 kg/cm², and involves transmitting pressure with a solid (AgCl). This means that the pressure is not truly hydrostatic, and the corrections required to allow for this are discussed. The measurements include 47 metallic and 5 non-metallic elements, 9 intermetallic compounds, 7 FeNi alloys and 3 semiconducting compounds; 31 of the metallic elements behave "normally," i.e. the resistance decreases with pressure and the curve is concave upwards. The 16 "abnormal" metals show a wide variety of behaviour and no simple generalizations are possible; while for semiconductors the magnitude of the pressure effects is much larger than for metals. There does not seem to be any general tendency for resistance to pass through a minimum with pressure, although a number of examples of minima were found. The change in resistance is compared with the change in volume under pressure, with particular reference to the complications due to the polymorphic transitions which occur in many cases. In general, the resistance shows much greater wealth of feature at high pressures than does the compressibility.

E. H. SONDHEIMER

537.311.31

838. On the changes of electrical conductivity of metals at the time of melting. II. G. SUTRA. *C.R. Acad. Sci.* [*Paris*] **235**, 707–9 (*Oct.* 6, 1952) *In French.*

The discontinuity at the melting point previously reported [Abstr. 8171 (1952)] is explained by supposing the conduction electrons in a metal to be limited in their volume of occupation to less than the total volume of the metal. C. A. HOGARTH

537.311.31

839. The electrical resistivity of indium-thallium solid solutions. J. W. STOUT AND L. GUTTMAN. *Phys. Rev.*, **88**, 713–14 (*Nov.* 15, 1952).

Measurements in the composition range from In to 50 atom % Tl and from the boiling point of He to room temperature are described. An anomalous behaviour of the resistivity of a specimen containing 30 atom % Tl indicates that it probably undergoes a transformation from face-centred cubic to tetragonal in the temperature interval 45–60°K. A.

537.311.31

840. The resistivity of lanthanum, cerium, praseodymium, and neodymium at low temperatures. N. R. JAMES, S. LEGVOLD AND F. H. SPEDDING. *Phys. Rev.*, **88**, 1092–8 (*Dec.* 1, 1952).

The electrical resistivity from room temperature to 2·2°K is presented. The hexagonal close-packed modification of La is found to possess a higher resistivity than the face-centred cubic. The mean of the observed superconducting transition temperatures for La is 5·8°K. Anomalies in the resistivity of Ce which occur at liquid N temperatures and between 11 and 14°K are discussed in connection with the crystal structure. An anomaly in the resistivity of Nd occurs at approximately 12°K. A.

537.311.31 : 538.632

841. On the electrical properties of Si containing aluminium. M. ISHIGURO, T. OKUNO AND A. UEDA. *Mem. Inst. Sci. Industr. Res, Osaka Univ.*, **9**, 1–3 (1952).

Conductivity σ and Hall coefficient R were measured as functions of temperature for "pure" Si and for Si containing 0·7% by weight of Al. The impure specimen was annealed for a long period and the measurements repeated, whereupon the mobility increased, R decreased, and σ increased also. The activation energy of the annealed specimen was 0·047 eV. The low value of carrier concentration ($\sim 10^{18}$ cm^{-3}) is not explained, considering the high impurity content and the phase diagram for Si–Al alloys. C. A. HOGARTH

537.311.32

842. Electrical resistivity of artificial graphite. J. OKADA AND T. IKEGAWA. Letter in *J. appl. Phys.*, **23**, 1282–3 (*Nov.*, 1952).

The electrical resistivity of artificial graphite specimens made by heating together pulverized coke and pitch, and then heating to higher temperatures is measured after the specimens have been cooled to room temperature. The results show the effect of variation of heat-treating temperature and enable the industrial process to be more or less controlled.

C. A. HOGARTH

537.311.33

843. Physical processes in semiconducting complexes. J. MARTINET. *C.R. Acad. Sci.* [*Paris*] **235**, 874–6 (*Oct.* 20, 1952) *In French.*

Current-voltage characteristics are illustrated for semiconducting specimens of mixed iron oxides, prepared by heating under pressure a mixture of powdered Fe_2O_3 and Fe_3O_4. An equation is developed for the passage of current through a potential barrier and it is shown that for low voltages (<0·1 V) the current-voltage relations for these specimens obey this equation, thus supporting the theory that the intergranular boundaries primarily control the current in such specimens. D. G. AVERY

537.311.33

844. Measurement of minority carrier lifetime in germanium. L. B. VALDES. *Proc. Inst. Radio Engrs*, **40**, 1420–3 (*Nov.*, 1952).

Basically, the method consists of liberating the carriers optically on a flat face of a crystal and measuring the concentration of minority carriers as a function of distance from the point of liberation. The mathematical model is analysed and experimental results are presented here. A.

537.311.33

845. Grain boundary barriers in germanium. W. E. TAYLOR, N. H. ODELL AND H. Y. FAN. *Phys. Rev.*, **88**, 867–75 (*Nov.* 15, 1952).

High resistance at crystal grain boundaries in *n*-type Ge is investigated. The resistance is symmetrical with respect to the direction of the current and resembles the characteristics of a rectifier in the

blocking direction. Such barriers are also photosensitive. The barrier is eliminated when the material is converted to *p*-type by nucleon bombardment or heat treatment. A theory is developed assuming the existence of surface states at the boundary. The ability of the barriers to withstand high voltages, around 100 V, is explained by showing that the surface charge increases with increasing voltage. The d.c. conductance of the barrier, measured at different temperatures, agrees with theory in the dependence on temperature as well as in the order of magnitude. At sufficiently low temperatures the barriers show a capacitance independent of the frequency, whereas at higher temperatures the barrier admittance is strongly frequency-dependent. These results are in agreement with the theory, showing that at low temperatures the current across the boundary is mainly carried by electrons, the hole current becoming increasingly important as the temperature is raised. The height of the potential barrier above the Fermi level is determined and found to be independent of temperature. A small difference in the measured breakdown voltage for the two directions of current is attributed to a difference in impurity concentration on the two sides of the boundary, which is confirmed by the a.c. measurements. The number of electrons on the boundary states is found to be of the order 10^{12} cm^{-2} at the breakdown, which may be the saturation of the boundary states. However, the field at breakdown is only a few times lower than the critical value for the onset of the Zener current, and this mechanism cannot be definitely ruled out. A.

537.311.33

846. Energy states of overlapping impurity carriers in semiconductors. C. ERGINSOY. *Phys. Rev.*, **88**, 893–4 (*Nov.* 15, 1952).

An analytical solution of the Schrödinger equation for the spherically symmetrical wave function of an impurity carrier in a zero wave number state is given on the basis of the Wigner–Seitz cellular approximation. An approximate method is described for calculating the small deviations from the hydrogenic values. The variation of the lower band-edge energies with impurity concentration shows that the excited impurity bands may overlap each other strongly, but a continuous decrease of the activation energy from its hydrogenic value to zero cannot be accounted for by interaction alone. A.

537.311.33

847. Acceptors produced in germanium by quenching from high temperatures. C. GOLDBERG. *Phys. Rev.*, **88**, 920–4 (*Nov.* 15, 1952).

Acceptors were produced in Ge single crystals by heating at high temperatures and then quenching very rapidly. Fuller *et al.* have measured the diffusion coefficient for these thermally produced acceptors and on the basis of their measurements the assumption is made here that the acceptor levels are due to Schottky defects. An expression is derived for the equilibrium density of ionized Schottky defects and on the basis of this theoretical expression and the experiments performed it is found that $(1{\cdot}49 \pm 0{\cdot}12)$ eV must be supplied to the crystal to form a Schottky defect. An estimate of $(2{\cdot}0 \pm 0{\cdot}1)$ eV is made for the "activation energy" of self-diffusion in Ge if diffusion occurs by a vacancy mechanism. A.

537.311.33 : 537.323

848. On the electrical conductivity and thermoelectric power of nickel sulphide. K. HAUFFE AND H. G. FLINDT. *Z. phys. Chem.*, **200**, 199–209 (*Sept.*, 1952) *In German.*

The conductivity σ of NiS and NiS + Ag_2S was measured as a function of the sulphur vapour pressure p_{S_2} at 700°C and as a function of the temperature. In the NiS phase σ is independent of p_{S_2}, and the temperature coefficient of σ is negative down to liquid air temperatures. For pure NiS $\sigma =$ 4800 ohm^{-1} cm^{-1} at 700°C; addition of Ag_2S decreases σ slightly. At vapour pressures $>$ 100 mm Hg σ decreases continuously with time, probably owing to transition to the NiS_2 phase. The thermoelectric power of Pt/NiS/Pt is about $-0{\cdot}0065$ mV/deg. at 700°C, independently of p_{S_2}, and that of Pt/NiS_2/Pt is about $+0{\cdot}005$ mV/deg. The results are regarded as suggesting that NiS is predominantly an intrinsic semiconductor in which the free electrons are degenerate at high temperatures. E. H. SONDHEIMER

537.311.33 : 669.783 : 621.315.59

849. Lifetime of injected carriers in germanium. D. NAVON, R. BRAY AND H. Y. FAN. *Proc. Inst. Radio Engrs*, **40**, 1342–7 (*Nov.*, 1952).

A method is described for determining the lifetime of injected carriers in a semiconductor by measuring the variation of the sample conductance after a voltage pulse has produced excess carriers. Volume and surface recombinations are separated by varying the sample dimensions. It is shown that carefully etched surfaces give very small surface-recombination velocity. The lifetime in high-resistivity Ge does not correlate critically with the resistivity, but can be changed greatly by heat treatment. Quenching from temperatures above 500°C reduces the lifetime drastically before the resistivity is appreciably affected. Preliminary measurements on some *N*-type as well as *P*-type Ge samples at low temperatures indicate that the lifetime first decreases upon cooling from room temperature, but the *N*-type samples at liquid nitrogen temperatures show a rapid decay of excess conductance superimposed on a much longer decay. A.

537.311.33

850. On the temperature effect of crystal rectifiers and the negative resistance. M. ISHIGURU AND T. MORI. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **8**, 74–7 (1951).

The rate of increase of reverse currents with temperature is found to be larger for Ge than for Si. The results are explained on the *P–N* junction theory of crystal rectification. C. A. HOGARTH

537.311.33

851. Properties of silicon and germanium. E. M. CONWELL. *Proc. Inst. Radio Engrs*, **40**, 1327–37 (*Nov.*, 1952).

Describes those fundamental properties of Ge and Si of interest for electronic devices, currently or potentially. Electrical properties, especially carrier density and mobility, have been treated in greatest

detail. Descriptive material has been provided to the extent necessary to give physical background. A.

537.311.33

852. The contact potential difference of selenium rectifiers. Y. MATUKURA AND A. OKAZAKI. *Mem. Fac. Sci. Kyūsyū Univ. B*, **1**, *No.* 2, 50–3 (*March*, 1952).

(*a*) Electrical and (*b*) thermal forming processes given to Se disks are described. It is found that there are three different values for the contact p.d. in three distinct ranges of forming temperature. The contact p.d. and barrier capacity tend to decrease after the forming process. These changes are explained by the assumption of metal ion diffusion into the Se from the counter electrode. C. A. HOGARTH

537.311.33 : 621.314.7

853. Interaction of barrier layers and statistical fluctuations in the three-electrode crystal [transistor]. H. F. MATARÉ. *J. Phys. Radium*, **13** (*Suppl. No.* 7–8–9) 112A–127A (*July–Aug.–Sept.*, 1952) *In French.*

The historical development of crystal amplifiers and transistors is reviewed. The effects of carrier injection on the older theories of rectification are discussed and interactions of holes and electrons in the barrier region are considered. The analysis is shown to be in agreement with that due to Shockley *et al.* and is developed in such a way as to explain the effects of current noise in transistors.

C. A. HOGARTH

537.311.33 : 621.314.7

854. Transistor electronics: imperfections, unipolar and analog transistors. W. SHOCKLEY. *Proc. Inst. Radio Engrs*, **40**, 1289–1313 (*Nov.*, 1952).

The electronic mechanisms that are of chief interest in transistor electronics are discussed from the point of view of solid-state physics. The important concepts of holes, electrons, donors, acceptors and "deathnium" (recombination centre for holes and electrons) are treated from a unified viewpoint as imperfections in a nearly perfect crystal. The behaviour of an excess electron as a negative particle moving with random thermal motion and drifting in an electric field is described in detail. A hole is similar to an electron in all regards save sign of charge. Some fundamental experiments have been performed with transistor techniques and exhibit clearly the behaviour of holes and electrons. The interactions of holes, electrons, donors, acceptors and deathnium give rise to the properties of *p–n* junctions, *p–n* junction transistors and Zener diodes. Point-contact transistors are not understood as well from a fundamental viewpoint. A new class of unipolar transistors is discussed. Of these, the analogue transistor is described in terms of analogy to a vacuum tube. A.

537.311.33 : 621.396.622

855. On the effect of fluctuations of crystal detectors. N. NIFONTOFF. *C.R. Acad. Sci.* [*Paris*] **235**, 1117–18 (*Nov.* 10, 1952) *In French.*

Noise in Si and Ge mixers and also a plate rectifier has been measured and briefly related to theories of Surdin and others [see also Abstr. 6504 (1952)].

C. A. HOGARTH

537.311.33 : 621.396.622 : 621.314.63

856. Frequency characteristics of the negative resistance of the Ge-rectifier. S. SATOMURA AND M. ISHIGURO. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **9**, 4–5 (1952).

The frequency effects of the back resistance of Ge rectifiers are investigated at various temperatures. The time lag of a.c. voltage applied increases its value with frequency and is measured by finding the frequency where the negative resistance decreases to zero. It is concluded that the effects are due to the thermal inertia of the system. C. A. HOGARTH

537.311.33 : 666

857. Electrical conductivity of boron-thallium glasses. B. I. MARKIN. *Zh. tekh. Fiz.*, **22**, *No.* 6, 941–5 (1952) *In Russian.*

The electrical conductivity of boron-thallium glasses was measured in the range of concentrations of the thallium oxide 20–75 weight %. The temperature relation is of the form $\log K = -A/T + B$. The mobility of the Tl ions for not too high concentrations of Tl_2O in the glass is slightly below the mobility of Ag ions. At high Tl_2O concentrations the mobility of Tl and Ag ions is equal and about 10× that of alkali metal ions. B. F. KRAUS

537.311.33 : 669.783

858. Single-crystal germanium. G. K. TEAL, M. SPARKS AND E. BUEHLER. *Proc. Inst. Radio Engrs*, **40**, 906–9 (*Aug.*, 1952).

The germanium discussed has a high degree of lattice perfection, which is favourable to the unimpeded flow of carriers (holes and electrons) in the solid in much the same manner that a high vacuum facilitates and simplifies the flow of electrons in an electronic tube. In addition to improvement of lattice perfection in the crystals, *p*-type and *n*-type conductivity regions have been produced within a single crystal. In the crystal-growing process the Ge is melted in a crucible and a small single-crystal seed dipped in the melt. The heat input and losses are then adjusted so that the desired size of crystal may be withdrawn at the desired rate of growth. When Ge solidifies, segregation of the impurities occurs so that most impurities concentrate in the liquid phase. Thus the growing crystal solidifies from a melt of continuously increasing impurity concentration, and shows a corresponding continuous increase in resistivity. Examples are shown of single-crystals with adjacent regions of different and constant resistivity. An important feature of the single-crystal Ge is the long lifetime of injected minority carriers. (The minority carrier in *n*-type material is the hole and in *p*-type material is the electron.) Lifetime measurements are described in which the material forms part of a phototransistor. The rectifying barriers between the *p*- and *n*-type sections behave in a manner predictable from the measured properties of each section. Examples are given of multiple-barrier structures. S. C. DUNN (R)

537.311.5

859. The [electrical] resistance of a truncated hemisphere. W. R. SMYTHE. Letter in *J. appl. Phys.*, **23**, 1280 (*Nov.*, 1952).

Upper and lower limits for this are calculated by replacing the truncated hemisphere by (*a*) a nest of

coaxial shells with insulating surfaces arranged in parallel, and (*b*) a stack of thin disks with perfectly conducting faces arranged in series. E. H. SONDHEIMER

537.312.5

860. Photoelectric measurements on ZnS single crystals. J. KRUMBIEGEL. Note in *Naturwissenschaften*, **39**, *No.* 19, 447 (1952) *In German.*

The photoconductivity of single crystals of ZnS (trace impurities Ca, Cu, Si, Mg and Fe) shows a spectral response with broad maxima at 7300Å and 11 500Å (no measurement below 4000Å). The photocurrent shows relatively slow growth and decay.

G. F. J. GARLICK

537.312.5 : 537.311.33 : 621.383

861. New photoelectric devices utilizing carrier injection. K. LEHOVEC. *Proc. Inst. Radio Engrs*, **40**, 1407–9 (*Nov.*, 1952).

The detection of injected carriers by their absorption and by emission due to their recombination with majority carriers is discussed. Two new components are proposed: (1) the "photomodulator," which permits modulation of a light beam by the change in absorption due to injected carriers (the photomodulator in connection with a phototransistor, or some other type of photocell, may be useful as an amplifier); and (2) the "graded seal junction," which permits the light to be transmitted to and from a *p–n*-junction without substantial absorption in the bulk semiconductor. A.

537.312.5 : 621.383.4

862. Use of the flying-spot scanner to study photosensitive surfaces. J. I. PANTCHECHNIKOFF, S. LASOF, J. KURSHAN AND A. R. MOORE. *Rev. sci. Instrum.*, **23**, 465–7 (*Sept.*, 1952).

A flying-spot tube was used to scan a large-area germanium photocell with a minute light spot. The output of the cell was amplified by a wide-band amplifier which controlled the intensity of a kinescope driven in synchronism with the flying-spot scanner. The display on the kinescope is a map of the photosensitivity at the surface of the photocell. A similar technique was also used to measure the frequency response of the photocell. A.

537.312.62

863. Superconductivity of indium-thallium solid solutions. J. W. STOUT AND L. GUTTMAN. *Phys. Rev.*, **88**, 703–12 (*Nov.* 15, 1952).

Measurements are reported on the superconducting properties of In–Tl solid solutions in the composition range from pure In to 50% Tl. The magnetic induction and the electrical resistance were measured at various temperatures and magnetic field strengths. Single crystal specimens of composition 0, 5, 10, 15 and 20 atom % Tl, and polycrystalline specimens containing 15, 20, 38 and 50% Tl, were investigated. In the more dilute solutions the penetration of field into the specimen at constant temperature was sharp and the restoration of resistance occurred at substantially the same field. As the concentration of Tl increased, the flux penetration occurred over a wider range of field and the resistance appeared only after practically all the flux had penetrated. For the single crystal specimens the trapped flux in zero field was less than 20% of that corresponding to unit permeability at the field where flux penetration begins. The breadth of transition in the polycrystalline specimens was like that of the single crystals, but the trapped flux was much larger. The critical fields for destruction of superconductivity are given for the range 0 to 20% Tl and the electronic heat capacities of the normal metal are calculated from them. A.

537.312.62

864. Some properties of superconductors below 1°K. III. Zr, Hf, Cd, and Ti. T. S. SMITH AND J. G. DAUNT. *Phys. Rev.*, **88**, 1172–6 (*Dec.* 1, 1952).

For Pt II, see Abstr. 1769 (1950). Using techniques for the measurement of the magnetic threshold curves of superconductors below 1°K previously employed, investigations have been made on Cd, Zr, Hf and Ti, both before and after heat treatment. It was found that, in Zr and Hf, the magnetic super-conducting properties were profoundly affected by heat treatment and that only after suitable annealing did these properties approach those of an ideal superconductor. The results for the annealed metals were as follows: the transition temperature, T_c, in zero magnetic field was 0·602°K for Cd, 0·546°K for Zr, 0·374°K for Hf, 0·558°K for Ti and the slope of the magnetic threshold curves at $T = T_c$ in gauss/degree was 112 for Cd, 170 for Zr, 230 for Hf and 450 for Ti. The magnetic threshold curves for Cd and Zr were parabolic with $H_0 = 33{\cdot}8$ gauss for Cd and 46·4 gauss for Zr. The thermodynamically computed specific heat of the normal electrons was $1{\cdot}54\times10^{-4}T$ cal/mole-deg for Cd and $3{\cdot}92\times10^{-4}T$ mole-deg for Zr. No thermodynamic computations were made for Hf and Ti owing to the irreversibility of their superconducting transitions. A.

537.312.62 : 536.21

865. The thermal resistivity of superconductors. D. P. DETWILER AND H. A. FAIRBANK. *Phys. Rev.*, **88**, 1049–52 (*Dec.* 1, 1952).

The thermal resistance of Sn, In and an alloy of Sn with 0·134% Bi have been measured as a function of transverse magnetic field strength from zero to values greater than critical at temperatures below their respective superconducting transition temperatures. Measurements have been carried out on Sn at several temperatures and with polycrystalline and single-crystal specimens. In all cases a distinct maximum is found in the intermediate state thermal resistance of the pure metals, while no such anomaly is observed in the alloy. The probable origin of this phenomenon is discussed. A.

537.36 : 541.135

866. Electrical phenomena at interfaces. J. A. V. BUTLER [Ed.]. *London, Methuen* (1951) vii + 309 *pp.* Review in *Proc. Phys. Soc.* [*London*] *B*, **65**, 828 (*Oct.*, 1952).

ELECTRIC DISCHARGES 537.52

537.523.4 : 537.527.4

867. Decay of light to very low levels from spark discharges. R. H. JOHNSON AND D. E. H. JONES. Letter in *Nature* [*London*] **170**, 669 (*Oct.* 18, 1952).

Reports measurements, with photo-multiplier tubes,

of afterglow effects following 100–10 000 A spark discharges in various gases and which persist for $\sim 500\ \mu$sec. The light intensity by that time had fallen to $\sim 10^{-6}$ or 10^{-7} of its initial value. Possible mechanisms are briefly discussed. J. D. CRAGGS

537.523.5 : 621.315.5.066.6

868. A similarity theorem in electrical contacts. P. M. DAVIDSON. *Brit. J. appl. Phys.*, **3**, 361–3 (*Nov.*, 1952).

The opening of a contact, up to the melting stage, causes a progressive change in the radius l of the interface; and the opening of contacts in different circuits may conveniently be described as similar processes provided (1) at any given stage (meaning at any given value of the contact potential) the maximum temperature is the same in all the contacts, (2) the spatial temperature distributions, when mapped on scales which make all their l's unity, give a single diagram, characteristic of the stage; (3) the same is true of their potential distributions; and (4) the ratio of their l's is the same at all stages. The conditions under which similarity will occur are investigated, the matter being important in contact theory and in the interpretation of experimental results. A.

537.525.4

869. Formative time lags of uniform field breakdown in N_2. G. A. KACHICKAS AND L. H. FISHER. *Phys. Rev.*, **88**, 878–83 (*Nov.* 15, 1952).

Formative time lags of spark breakdown in N_2 have been measured in uniform fields as a function of % overvoltage, pressure (150 to 700 mm Hg) and electrode separation (0·3 to 1·4 cm). For the range of variables studied the formative time lags are almost identical with values previously observed in air; the time lags vary from 100 μsec close to threshold to 1 μsec at a few % overvoltage. The present data as well as the earlier measurements in air indicate a secondary mechanism of photoemission of electrons either from the cathode or from the gas near the cathode. This mechanism requires a large number of successive electron crossings. The dependence of the sparking potential on the number of initiating electrons has been determined; the sparking potential of pure N_2 shows an enormous dependence on the value of the primary current. A.

537.525.5 : 621.3.032.2 : 621.3.014.1

870. Current densities of free-moving cathode spots on mercury. H. v. BERTELE. *Brit. J. appl. Phys.*, **3**, 358–60 (*Nov.*, 1952).

Although a current density of about 4000 A/cm² is generally considered as characteristic of cathode spots on mercury pools, values of 10^4–10^7 A/cm² have recently (1948) been measured. When these densities are plotted against the time which has elapsed since spot initiation. a curve is obtained which shows a steady decrease of current with the lifetime of the spot. From this curve which holds for a single spot, and from the distribution of spot sizes which exists when a number of spots are simultaneously present on the pool surface, it may be concluded that a continuous expansion of the area of each spot takes place. Hence the current density is not a significant constant of spot emission, but its value may show considerable variation. Only when the lifetime is large, e.g. in temperature investigations of the mercury pool of technical discharge devices, can the low classical value for the current density be used. A.

537.525.8

871. Electron removal in krypton afterglows. J. M. RICHARDSON. *Phys. Rev.*, **88**, 895–900 (*Nov.* 15, 1952).

The decay of the electrodeless microwave discharge in samples of Kr at 0·5 to 25 mm Hg was studied by the recently developed techniques of electron-concentration, optical spectrographic and optical photometric measurements as a function of time after termination of the exciting fields out to a maximum of 15 Mc/s. The Kr samples unavoidably contained traces of Xe estimated to be of the order of 0·01 to 0·1 mole %, and such quantities of Xe were found to enter importantly into the afterglow processes of recombination and radiation in the pressure range 6 to 25 mm Hg. The observations are interpreted in terms of dissociative recombination of the molecular ions Kr_2^+ or $(MXe)^+$ (where M is an undetermined atom, either Kr or Xe) with subsequent atomic radiation by an excited dissociation product. For Kr, one quantum from various $2p$ to $1s$ transitions appears to be associated with each recombination event. Recombination coefficients of approximately $0{\cdot}6\times10^{-6}$ and 2×10^{-6} cm³/electron-sec are obtained for the Kr and Xe recombination process, respectively. These values do not appear to be pressure-dependent. Results of ambipolar diffusion measurements are also stated. A.

537.525.8

872. On a resonance effect in electrodeless high frequency gas discharges in a superimposed magnetic field. A. LINDBERG, H. NEUERT AND H. WEIDNER. Note in *Naturwissenschaften*, **39**, *No.* 16, 374–5 (1952) *In German.*

Electrodeless discharges were established at frequencies $\sim$ 20–70 Mc/s at pressures varying from 10^{-3} to 10^{-1} mm Hg in gases, notably hydrogen and argon. An external magnetic field, perpendicular to that in the discharge, was established. Resonances at particular frequencies related to the external field strengths were observed, characterized by changes in light emission and by a reaction on the exciting circuit. The effect is briefly discussed. J. D. CRAGGS

537.525.8 : 537.525.72

873. The study of the changes in pressure rise and current in a low frequency discharge due to irradiation. V. V. AGASHE. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 740 (*Sept.*, 1952).

Briefly describes expts. on ozonizer discharges in hydrogen of the type associated with the Joshi effect, in which the rise in tube pressure due to irradiation with electric lamps was measured. Tentative explanations of the results are given. J. D. CRAGGS

537.525.8 : 621.316.722 : 621.387

874. The characteristics of some miniature high-stability glow-discharge voltage regulator tubes. G. GRIMSDELL; F. A. BENSON. Letters in *J. sci. Instrum.*, **29**, 301 (*Sept.*, 1952).

The first letter gives comments on Benson's earlier work, with special reference to the hysteresis effect and slow drifts in characteristics. Benson's reply refers to these matters and also to initial drifts in characteristics. J. D. CRAGGS

537.527.5

875. On the determination of plasma temperatures in xenon high pressure arcs. K. LARCHÉ AND H. SCHIRMER. Note in *Naturwissenschaften*, **39**, *No.* 16, 376 (1952) *In German.*

Briefly discusses the approach to black-body conditions in high-pressure arcs, and shows how the temperatures of 0·95 atm. arcs (40 A) reach values of about 6000–8000°K, depending on the conditions of external cooling, etc. J. D. CRAGGS

537.529

876. A contribution to the problem of breakdown of solid insulators. K. W. BÖER, U. KÜMMEL AND R. ROMPE. *Z. phys. Chem.*, **200**, 180–9 (*Aug.*, 1952).

The effects of irradiation with visible light, on the conduction current and electric strength of CdS single crystals, are discussed in relation to the theories of thermal and intrinsic breakdown. J. H. MASON

537.529 : 621.317.31 : 621.315.61.015.533

877. The character and measurement of brush discharge ionization in dielectrics. D. RENAUDIN. *Bull. Soc. Franç. Elect.* (*Sér.* 7) **2**, 431–5 (*Aug.*, 1952) *In French.*

Consideration of the phenomenon indicates that the ionization density in a dielectric can be expressed as the mean ionization current per unit capacitance. This was measured with a high-gain tuned amplifier and a linear detector and plotted as a function of the applied voltage. Some preliminary results on transformers are given. This method is more sensitive than the Schering bridge. See also Abstr. 3153 (1952).

I. D. L. BALL (R)

X-RAYS 537.531

537.531 : 535.33

878. Penetration and diffusion of X-rays: calculation of spatial distributions by semi-asymptotic methods. L. V. SPENCER. *Phys. Rev.*, **88**, 793–803 (*Nov.* 15, 1952).

Methods are presented for calculating X-ray spectra in an infinite homogeneous medium. These methods are particularly useful for calculating spectra at great distances from the radiation source. The transport equation is solved numerically by characterizing angular and spatial distributions with a small number of suitable parameters. Attention is called to a mathematical technique which is extremely useful for this purpose, whereby a function may be approximated from a knowledge of moments, derivatives, or values. Sample numerical applications include spectral intensities at various distances from a plane monodirectional 10·22 MeV X-ray source in Pb and a plane monodirectional 5·11 MeV source in Fe. A.

537.531 : 535.338 : 535.343

879. Preliminary remarks on the *L* spectrum, the conductivity band and the colour of silver. Y. CAUCHOIS. *C.R. Acad. Sci.* [*Paris*] **235**, 613–15 (*Sept.* 22, 1952) *In French.*

The emission and absorption spectrum of silver *L* radiation has been examined with a focusing spectrograph. The $L\beta_2$ emission line has a weak tail on the high-frequency side of width 4 eV, which ends at the frequency where the *L* absorption edge starts. The tail is thus due to the conduction electrons. The width found is in good agreement with the optical absorption spectrum. R. S. PEASE

537.531 : 535.345

880. Theoretical prediction of differences in the absorption-coefficients of pure water and sea water, in the X-ray region. B. SAINT-GUILY. *C.R. Acad. Sci.* [*Paris*] **235**, 893–4 (*Oct.* 20, 1952) *In French.*

Taking into account chlorine and sodium only, the calculated absorption of sea water is about one and a half times that of water between $\nu = 6{\cdot}83 \times 10^{18}$ and $\nu = 1{\cdot}00 \times 10^{19}$. Above and below this region there is equal absorption. No measurements have been made. C. TURNER

537.531 : 535.43

881. Small angle X-ray scattering from compact identical particles. R. M. FRANK AND K. L. YUDOWITCH. *Phys. Rev.*, **88**, 759–60 (*Nov.* 15, 1952).

A general expression is deduced for the intensity distribution of X-rays scattered at small angles from a compact system of identical particles. The scattering element selected for this derivation includes several near neighbours with the origin particle, thus taking cognizance of short-range order. An inherently positive intensity distribution may then be deduced for any such system describable by an "average" radial electron density which may be approximated by linear segments. This approximation for a compact system of impenetrable spheres compares favourably with the meagre data available. A.A.

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

882. Quantum effects in the radiation from accelerated relativistic electrons. L. I. SCHIFF. *Amer. J. Phys.*, **20**, 474–8 (*Nov.*, 1952).

The radiation associated with the operation of a betatron or synchrotron, due to the transverse acceleration of relativistic electrons by the magnetic field of the machine, is discussed qualitatively. Order-of-magnitude expressions for the angular opening of the cone within which the radiation is emitted, and for the wavelength of the maximum of the radiated spectrum, are obtained by means of qualitative arguments based on classical physics. It is then shown, from a consideration of the rate of spread of a wave packet that describes the electron, that quantum effects are negligible so long as the ratio γ of the total energy to the rest energy of the electron is small in comparison with the square root of the ratio of the orbit radius R to the reduced Compton wavelength γ_c of the electron. This criterion for the validity of classical theory is substantially equivalent to, but not identical with, the commonly accepted criterion $\gamma^2 \ll R/\lambda_c$, which is derived from the assumption that the momentum of an emitted photon must be small in comparison with the momentum of the electron. Thus classical theory is expected to be valid for electron energies small in

comparison with 10^{15} eV if the magnetic field strength does not exceed 10^4 oersted. A.

537.533

883. The effect of surface treatment on electrical breakdown between copper electrodes at 50 cycles at very low pressures. R. J. B. HADDEN. *Atomic Energy Res. Establ.* [*Harwell*] *Rep. G/M* 92, 6 *pp.* (*Aug.*, 1951).

Attempts to increase the vacuum breakdown voltages of gaps by electrolytically polishing the electrodes, thus reducing field emission, have been investigated by a comparison of the 50 c/s breakdown between electrolytically polished and between unpolished spectroscopically pure copper electrodes. No increase of breakdown voltage was noted.

F. LLEWELLYN JONES

537.533

884. The slope of logarithmic plots of the Fowler–Nordheim equation. J. M. HOUSTON. *Phys. Rev.*, **88,** 349–50 (*Oct.* 15, 1952).

The slope of logarithmic plots of the Fowler–Nordheim equation for electron field emission is expressed in terms of the surface work-function and a tabulated function, $s(y)$. This new function, $s(y)$, is derived from Nordheim's $v(y)$ which appears in the exponent of the Fowler–Nordheim equation. Values of $v(y)$ are also tabulated and are believed to be more exact than Nordheim's original values. A.

537.533

885. The work function of the electrons at some of the faces of a tungsten monocrystal. B. G. SMIRNOV AND G. N. SHUPPE. *Zh. tekh. Fiz.*, **22,** *No.* 6, 973–80 (1952) *In Russian.*

The ratios between the work functions at some of the faces of tungsten monocrystals fused to form spherules of a few μ diameters were measured in cold emission. The ratio of the max. and min. work function $\sim 1{\cdot}3$, whereas the values of the work function of the faces, obtained by approximate theoretical calculation of the radius of the emitter are $\sim 4{\cdot}2$–$5{\cdot}5$, i.e. the difference of the work function of different faces > 1 eV. B. F. KRAUS

537.533

886. Velocity distribution of electrons in field emission. Resolution in the projection microscope. R. GOMER. *J. chem. Phys.*, **20,** 1772–6 (*Nov.*, 1952).

The velocity distribution of electrons in field emission has been calculated on the basis of a simple free electron or one-band model. It is found that the component of velocity transverse to the direction of emission varies approximately as the square root of the applied field. This leads to the result that resolution in the field emission microscope is practically independent of applied voltage, since transit times vary as $V^{-\frac{1}{2}}$; resolution turns out to be of the order of 30 Å. Image formation in the case of molecules and the resolution obtainable with the proton microscope are briefly discussed. A.

537.533 : 537.312.5

887. Field emission from photoconductors. L. APKER AND E. TAFT. *Phys. Rev.*, **88,** 1037–8 (*Dec.* 1, 1952).

Field emission current was drawn from sharp needles of the photoconductors CdS and CdSe. It increased greatly when light that excited photoconductivity was incident on the emitting area. Possible mechanisms are mentioned. A.

537.533 : 621.384.612

888. A 35-million volt synchrotron. O. WERNHOLM. *Ark. Fys.*, **5,** *Paper* 27, 565–80 (1952).

A general description of a synchrotron giving electrons of energies of 3–35 MeV. The magnet operates at 50 c/s and the r.f. is 238 Mc/s. The electron source gives 3 μsec pulses at 18k eV into a Pyrex vacuum chamber, and outputs up to 1 r/min at 1 m have been obtained. J. H. FREMLIN

537.533 : 621.384.613

889. The Zurich betatron. *Atomics* [*London*] **3,** 230–3, 242 (*Sept.*, 1952).

The 31 MeV dual-beam betatron installation (primarily intended for cancer therapy) at the University Radiological Institute, Zurich, is described. A distributed yoke magnet is used, with correction windings wound on the toroidal vacuum tube. Two electron guns operate on alternate half-cycles and produce two independently controllable X-ray beams, 180° apart. Collimators made from lead particles mixed with thermosetting resin define treatment areas varying between 7 and 314 cm². A general plan and four photographs illustrate the layout of the betatron and associated rooms. Details of operating arrangements, shielding and protective devices are given. J. J. WILKINS

537.533.72

890. Results of numerical calculations of the trajectories of electric corpuscles in the field of an elementary magnet. VIII. Periodic trajectories and trajectories in their vicinity. C. STØRMER. *Skr. Norske VidenskAkad., Oslo Kl. I,* **1950,** *Paper* 1, 75 *pp. In French.*

For Pt VII, see Abstr. 3557 (1951). The results are given in six figure tables, and a plate showing the projections of the periodic orbits in the equatorial and meridian planes. J. HUGHES

537.533.72

891. Crooked trajectories for charged particles in a magnetic field with a plane of symmetry. J. LAFOUCRIÈRE. *J. Phys. Radium,* **13,** 392–400 (*July–Aug.–Sept.*, 1952) *In French.*

With the restriction of an inhomogeneous magnetic field with a plane of symmetry, and a strong radial fall-off, a general method is given for the construction of the crooked trajectories of charged particles in this field. These trajectories are systematized, and the problem of axial focusing for stationary orbits discussed. J. HUGHES

537.533.72

892. Paraxial electron trajectories in electrostatic lenses. C. FERT. *J. Phys. Radium,* **13** (*Suppl. No.* 7–8–9) 83A–90A (*July–Aug.–Sept.*, 1952) *In French.*

The classical step-by-step method of integration for obtaining electron trajectories can be formulated in such a way that all the constants of any lens system can be expressed in terms of the coefficients of a characteristic matrix (second order and square). It is the product of several similar matrices each associated with a plane of discontinuity of the system. The theory is illustrated by a number of examples.

G. D. SIMS

537.533.72

893. A method of calculation of trajectories in electron optics. Generalization to linear homogeneous differential equations. F. BERTEIN. *J. Phys. Radium*, **13** (*Suppl. No.* 7–8–9) 91A–98A (*July–Aug.–Sept.*, 1952) *In French.*

A generalization of the method described in Abstr. 5832 (1952). An estimation of the error involved at any stage is given and the factors affecting the choice of the base polynomials for lens and mirror problems are discussed. G. D. SIMS

537.533.72

894. Double focusing of charged particles with a wedge-shaped, non-uniform magnetic field. R. M. STERNHEIMER. *Rev. sci. Instrum.*, **23**, 629–34 (*Nov.*, 1952).

The pole faces of a wedge-shaped magnet can be shaped so as to reduce the image distance for simultaneous horizontal and vertical focusing, and thereby increase the intensity at the image. The field inside the magnet is assumed to behave as r^{-n}, where r is the distance from the centre of curvature of the normal path and n is a constant parameter. Equations are obtained for the image distance for double focusing, and the results of calculations for several representative cases are shown. It is shown that by appropriate choice of the non-uniform field, the image distance can be appreciably reduced in all cases of interest. A.

537.533.72 : 621.317.729

895. An automatic electron trajectory tracer. F. CASSANAS AND P. BARCHEWITZ. *J. Phys. Radium*, **13** (*Suppl. No.* 7–8–9) 73A–83A (*July–Aug.–Sept.*, 1952) *In French.*

Describes an electrolytic tank employing a double probe and using a modified carriage operating on the Gabor–D. B. Langmuir principle. The trajectories or equipotentials are automatically traced on a surface immediately above and parallel to the plane of the tank. The errors inherent in the system are discussed at some length, the mean accuracy having been found practically to be of the order of 0·2%. G. D. SIMS

537.533.72

896. On the resolving power of the electrostatic immersion objective. A. SEPTIER. *C.R. Acad. Sci.* [*Paris*] **235**, 609–11 (*Sept.* 22, 1952) *In French.*

The resolving power of an emission electron microscope was measured, using a microscope with a classical immersion objective and an object heated by electronic bombardment of its front face. The results obtained were better than those predicted by a given approximate formula. G. D. SIMS

537.533.72

897. An electrostatic immersion objective with high resolving power, of a new type. A. SEPTIER. *C.R. Acad. Sci.* [*Paris*] **235**, 652–4 (*Sept.* 29, 1952) *In French.*

Describes an objective which is, essentially, a unipotential lens placed in front of a plane cathode, for which the cathode field is large and sensibly independent of the focusing potential. The objective, when corrected for coma, can resolve objects with a separation of 100 mμ. G. D. SIMS

537.533.73

898. Electronic fringes possessing a centre of symmetry. E. PERNOUX. *J. Phys. Radium*, **13** (*Suppl. No.* 7–8–9) 135A–136A (*July–Aug.–Sept.*, 1952) *In French.*

Describes the production of fringes in electron microscope images of thin single crystals of PbI_2 and MoO_3. The fringes have 4-fold or 6-fold symmetry depending on the crystal, and their orientation is related to the crystal structure concerned. J. THEWLIS

537.533.73 : 548.74

899. Influence of absorption on the structure of Kikuchi bands and the light-dark structure observed when the source lies within the crystal [Gitterquellen-interferenz]. H. PFISTER. *Z. Naturforsch.*, **7a**, 499–500 (*July*, 1952) *In German.*

The dependence of the intensity and width of the Kikuchi bands on the thickness of the crystal plate under examination, and hence on the electron absorption, is considered in the case of PbI_2. The effects are analogous to those observed with X-rays when the source of radiation lies within the crystal. J. THEWLIS

537.533.75

900. Discrete energy losses of 35 keV electrons in exchanges with atoms and molecules. G. MÖLLENSTEDT. *Z. Naturforsch.*, **7a**, 465–70 (*July*, 1952) *In German.*

Describes the use of an electrostatic velocity analyser [see Abstr. 5038 (1950)] in the study of electron collisions with N_2, O_2, H_2, He, C_6H_6, CO_2, H_2O, C_6H_4 and ethyl ether. Good agreement is obtained with results for slow electrons obtained by other investigators and the reliability of the method is demonstrated. A. H. W. BECK

537.533.75

901. On the chromatic losses of electrons in their passage through matter. G. MÖLLENSTEDT. *Optik*, **9**, *No.* 10, 473–80 (1952) *In German.*

Discusses the use of the author's velocity analyser [Abstr. 5038 (1950)] in elucidating discrete energy losses. The performance of the analyser is discussed. With an oxide cathode the resolving power, at about 40 kV, is about 70 000. The analyser is used to investigate collisions in gases and the effect of angle of incidence on solid materials. Methods of using the chromatically scattered electrons are briefly discussed. A. H. W. BECK

537.533.75

902. Ionization loss and straggling of fast electrons. E. L. GOLDWASSER, F. E. MILLS AND A. O. HANSON. *Phys. Rev.*, **88**, 1137–41 (*Dec.* 1, 1952).

The most probable energy loss of 9·6 and 15·7 MeV electrons in samples of about one gram per cm^2 of Be, polystyrene, Al, Cu and Au has been measured. The losses measured were of the order of one MeV, and the resolution of the apparatus made possible an accuracy of 20 keV. The observed distributions of energy losses are found to be in good agreement with the Landau straggling calculations for the light elements. For the heavier elements there is a spreading of the distribution introduced by radiation and K

electron effects. Calculations made by Yang and Kennedy for Au, including these effects, check well with the experimental data. Applying Fermi's correction for the polarization effect at extreme relativistic velocities to Landau's result for the most probable energy loss, one obtains for the predicted loss in MeV $\Delta_{pc} = 0{\cdot}1537D(\Sigma Z/\Sigma A) \times [19{\cdot}43 + \ln(D/\rho)]$, where D is the absorber thickness in g/cm² and ρ is the absorber density in g/cm³. Experimental results for the light elements are in excellent agreement with this theory. The heavier elements show losses somewhat smaller than those calculated. A.

537.533.8

903. Pair production by electrons. M. Camac. *Phys. Rev.*, **88**, 745–50 (*Nov.* 15, 1952).

Pair production by electrons was observed by measuring the positrons emitted from thin copper targets irradiated directly by the synchrotron electron beam (230 ± 20 MeV energy). The positrons were produced in either of two ways: either (1) directly by the electron beam, or (2) through a double process in which bremsstrahlung was first produced which then materialized in pairs in the same target. By measuring the positron rate as a function of target thickness a direct comparison of the two modes of production was obtained. The thickness of copper from which the positron yield was the same for both processes was 0·0043 ± 0·001 in. (0·0073 ± 0·0017 radiation lengths). The positrons had about 0·80 of the energy of the incident electron beam. The results of this experiment is shown to be in agreement with the Weizsaker–Williams approximation. In this approximation the formula for the number of virtual quanta associated with an incident electron contains a constant of the order of unity. Using the results of this experiment and the Bethe–Heitler formulae for the double process this constant was calculated to be 1·6 ± 0·2. A.

537.533.8

904. The mechanism of field dependent secondary emission. H. Jacobs, J. Freely and F. A. Brand. *Phys. Rev.*, **88**, 492–9 (*Nov.* 1, 1952).

In recent experimental investigations, it was found that secondary emission ratios as high as 10 000 to 1 could be attained utilizing field dependent secondary emission from magnesium oxide. Early tests showed the mechanism causing the high gains to be fundamentally different from the more standard secondary emission phenomenon. The hypothesis was made that the mechanism of field dependent secondary emission was a process similar to that of the "Townsend avalanche" occurring in gas discharges. As the surface of the dielectric film was bombarded with primary electrons, the high resistivity of the material in combination with the secondary emission current caused the surface to charge to the potential of the collector grid, producing a high field within the dielectric. Electrons released within the material could then gain enough energy to liberate additional electrons, and an avalanche type process resulted. Experiments proved to be consistent with the above theory. (1) The high yields appeared to be independent of the base material. This indicated that the surface or volume effects were most important, implying that a Fowler type field emission from the base metal was not a significant factor. (2) In studying the secondary current as a function of field, the gas discharge equations were found to be correct. These equations predicted a straight line plot of the $\ln \ln\delta$ *v.* $1/E$, and in addition, gave a close estimate of the magnitude of the secondary emission ratio. (3) By means of retarding potential measurements, the energies and mean free paths of the emitted secondary electrons were determined. This data was in good agreement with the results in item (2). (4) The rise time for surface charging was determined by using square wave variations of bombarding currents, and was found to be consistent with the original hypothesis. A.

537.533.8 : 621.385.15

905. Secondary electron emission from barium oxide. J. Woods and D. A. Wright. *Brit. J. appl. Phys.*, **3**, 323–6 (*Oct.*, 1952).

The effect of temperature on the secondary emission of BaO is found to be small between room temperature and 600°C. With evaporated layers, the d.c. value of the secondary emission coefficient at a bombarding energy of 240 V falls from near 3 at 10^{-6} cm to about 2 at 10^{-4} cm. The pulsed value is about twice as large as the d.c. for the thinner films. For sprayed coatings the coefficient is near 2, and is the same for d.c. as for pulsed. During operation there are rather complex short-time effects, but over a long period the coefficient falls, and decomposition of the oxide occurs. A.

537.534 : 621.317.71

906. Combined current integrator and sensitive microammeter. H. A. Enge. *Rev. sci. Instrum.*, **23**, 599–600 (*Nov.*, 1952).

This simple current integrator, designed for use with electrostatic accelerators, is capable of integrating currents higher than 10^{-8} A. The incoming current charges a condenser which is discharged at a certain voltage by an electronic device; the number of discharges is counted on a mechanical counter. A compensation resistor in the input circuit of the integrator is at the same time utilized as a shunt resistor for an electronic microammeter with full-scale readings, 1, 2 and 10 μA. A.

537.534 : 621.384.612

907. The strong-focusing synchroton—a new high energy accelerator. E. D. Courant, M. S. Livingston and H. S. Snyder. *Phys. Rev.*, **88**, 1190–6 (*Dec.* 1, 1952).

Strong focusing forces result from the alternation of large positive and negative n-values in successive sectors of the magnetic guide field in a synchrotron. This sequence of alternately converging and diverging magnetic lenses of equal strength is itself converging, and leads to significant reductions in oscillation amplitude, both for radial and axial displacements. The mechanism of phase-stable synchronous acceleration still applies, with a large reduction in the amplitude of the associated radial synchronous oscillations. To illustrate, a design is proposed for a 30 BeV proton accelerator with an orbit radius of 300 ft, and with a small magnet having an aperture of 1 × 2 in. Tolerances on nearly all design parameters are less critical

than for the equivalent uniform-n machine. A generalization of this focusing principle leads to small efficient focusing magnets for ion and electron beams. Relations for the focal length of a double-focusing magnet are presented, from which the design parameters for such linear systems can be determined. A.

537.534 : 621.384.622.1

908. Radial focusing in the linear accelerator. J. P. BLEWETT. *Phys. Rev.*, **88**, 1197–8 (*Dec.* 1, 1952).

The focusing mechanism described in the preceding abstract is applied to the linear accelerator. The defocusing forces in the linear accelerator are derived and the particular example of a 4-million-volt-accelerator 10 m long is discussed. It is shown that the defocusing forces can be compensated by magnetic or electric lenses of the alternating gradient type using easily attainable field gradients. For example, a defocusing field gradient of 1000 volts per centimetre on a 100 kV proton beam can be compensated by a lens 20 cm long with field gradients of the order of 1000 gauss per centimetre. A.

537.534 : 621.384.62

909. A demountable accelerator tube. D. R. CHICK AND F. J. MIRANDA. Letter in *J. sci. Instrum.*, **27**, 337–8 (*Dec.*, 1950).

Electron loading is probably one of the principal causes of low breakdown voltage of positive ion accelerator tubes. In order to study its effects and means of control the tube has accelerating electrodes which are readily changed with the least disturbance to the vacuum seals. The tube is 9 ft long, 10 in. i.d., and is designed to operate in a pressure-insulated electrostatic generator. It consists of 43 shallow porcelain rings cemented to mild steel diaphragms which support dished aluminium electrodes. Details are given of the properties of the cement, a cold-setting resin, and of the method of construction.

F. J. MIRANDA

537.534 : 621.384.62

910. The initial performance of a proton accelerator tube; deterioration and its causes. F. J. MIRANDA AND D. R. CHICK. Letter in *J. sci. Instrum.*, **29**, 340–1 (*Oct.*, 1952).

The tube operated in a pressure insulated Van de Graaff generator (preceding abstract) and withstood up to 3·4 MV with a 35 μA beam, but after six months 2·5 MV could be held with difficulty. Discharges had caused heavy erosion of the anode surfaces and condensation of metal on the cathodes and insulating wall. A large number of carbon tracks were also found, due to puncture of resin at the vacuum seals. The causes of damage, which are being investigated, are briefly discussed and possible remedies are suggested.

F. J. MIRANDA

537.534.74

911. Elastic scattering of 9·7-MeV protons by deuterium and by hydrogen. J. C. ALLRED, A. H. ARMSTRONG, R. O. BONDELID AND L. ROSEN. *Phys. Rev.*, **88**, 433–8 (*Nov.* 1, 1952).

The proton-deuteron and proton-proton differential scattering cross-sections have been measured with a 9·7 MeV cyclotron external proton beam and with photographic plates as detectors of the scattered particles. In both interactions the angular distributions are similar to those observed at lower energies, and the total cross-sections are in good agreement with reasonable extrapolations of the low energy data. The p–d data show some evidence for deuteron disintegration. Neglecting spin-orbit coupling, the p–p data are consistent with pure S-wave scattering with a phase shift of $57{\cdot}8° \pm 1{\cdot}2°$. A.

537.534.74

912. Proton triton interaction. J. S. MCINTOSH, R. L. GLUCKSTERN AND S. SACK. *Phys. Rev.*, **88**, 752–9 (*Nov.* 15, 1952).

A phase shift analysis of the Los Alamos data on p–T scattering for incident protons of 0·708 to 2·548 MeV is carried out using singlet and triplet s and p phase shifts. The large p wave phase shifts obtained are shown to be consistent with the suggested ^1P resonant level of the α-particle. The effect of absorption associated with the T(p, n)He^3 reaction is taken into account by means of a schematic resonance model. A satisfactory fit is obtained with attractive singlet and triplet potentials of depths ~ 46 MeV and ~ 11 MeV, respectively. The singlet depth is chosen to give the observed bound state of the α-particle. A.

537.534.74

913. High energy proton–proton scattering and associated polarization effects. L. J. B. GOLDFARB AND D. FELDMAN. *Phys. Rev.*, **88**, 1099–109 (*Dec.* 1, 1952).

Three phenomenological descriptions of p–p scattering have been proposed to date, two of which, the singular tensor-force model of Christian–Noyes and the L.S force model of Case–Pais, are characterized by a singular triplet potential. The Jastrow model introduces a hard core in the singlet interaction. The parameters of these various potentials were all determined, in part, by use of Born approximation estimates of triplet scattering cross-sections at high energies. Inasmuch as the validity of such estimates is not clear in those cases where the interaction is singular, more exact calculations have been performed at 240 MeV with the singular potentials (and also, for comparative purposes, with the well-behaved triplet interaction of Jastrow) using Schwinger's variational method and/or numerical integration procedures. Such calculations have also been performed at 450 MeV for the singular tensor-force model. To insure the existence of solutions, a zero cut-off has been introduced in the singular potentials at distances of the order of the nucleon Compton wavelength. It is found that, in all instances where the potential is singular, the Born approximation and the use of Born approximation trial functions in a variational treatment are completely unreliable. More exact calculations of the differential scattering cross-sections than those in Born approximation introduce large anisotropies in the case of the singular interactions and, in particular, in the case of the L.S potential. The hard-core model, on the other hand, is in qualitative agreement with experiment. Also discussed are the results of calculations of polarization effects in a double p–p scattering and their implications for the various potentials considered. A.

537.534.8

914. Secondary emission from metals under bombardment with positive ions of lithium. G. COUCHET. *C.R. Acad. Sci.* [*Paris*] **235**, 944–6 (*Oct.* 27, 1952) *In French.*

In connection with the development of an ionic microscope, the secondary emission caused by Li^{++} ions has been measured for mumetal, duralumin and stainless steel. The ratio increases to a flat maximum of between 1·0 and 1·5 for primary voltages of about 15 kV. A. H. W. BECK

DISCHARGE TUBES . COUNTERS 537.54

537.542

915. A radiofrequency ion source. C. P. SWANN AND J. F. SWINGLE, JR. *Rev. sci. Instrum.*, **23**, 636–8 (*Nov.*, 1952).

An r.f. ion source with transverse magnetic field giving 50 μA of resolved protons with a gas flow of less than 1 cm³ per hour and with a power input of 150 W is described. The effect of magnetic field upon power requirements is discussed. With increased gas flow resolved currents in excess of 100 μA of protons have been obtained. A.

537.542 : 413 : 389.6 : 621.387.42

916. Standards on gas-filled radiation counter tubes: definitions of terms, 1952. *Proc. Inst. Radio Engrs*, **40**, 924–6 (*Aug.*, 1952).

537.542

917. Proportional counters in corona region. L. COLLI, U. FACCHINI AND E. GATTI. *Rev. sci. Instrum.*, **23**, 621–3 (*Nov.*, 1952).

The behaviour of cylindrical counters filled with A of various purities has been studied in the corona discharge zone. In this zone the counters act in a normal proportional manner with regard to the detection of α-particles. The amplitude of pulses obtained is found to be independent of applied voltage over an interval of about 1000 V. The discharge mechanism is briefly discussed. A.

537.542

918. Discharge mechanism in argon counters. L. COLLI AND U. FACCHINI. *Phys. Rev.*, **88**, 987–98 (*Dec.* 1, 1952).

The multiplication curves and the pulse shapes have been studied in a counter filled with pure A and A + CO_2 mixtures at pressures ranging from 150 to 1000 mm Hg. The pulse shapes in A in the high proportional zone and up to voltages corresponding to the corona threshold are explained by assuming a production in the Townsend avalanche of photons hard enough to extract electrons from the cathode. These photoelectrons are found to be produced during a time T_{f_0} of the order of a few μsec when at 150 mm Hg pressure, and during a smaller time when at higher pressures. The analysis of the features of the excited levels of A suggests the four lower excited levels to be responsible for the photoelectric effect. These photons are produced in collisions leading to destruction of these levels, and are not resonance photons. The T_{f_0} values deduced from our measurements are in accordance with those obtained by extrapolating the Molnar values for the first metastable levels at the pressures used. This photoelectric process has been found to be the main one responsible for sustaining corona discharge, which starts at multiplication values of about 200. If CO_2 concentrations varying from 10^{-4} to 5×10^{-3} are added to A, one obtains an increase of N_S, the threshold multiplication, which is linear *v.* the CO_2 percentage. This fact is readily explained by assuming the quenching of A excited levels by collisions of the second kind on CO_2 molecules. From the experimental results one may deduce a value of the quenching cross-section which is about 600×10^{-16} cm² in a first approximation. Further studies concern the space charge effect at the photoelectric process divergence threshold, which allows the formation of a very narrow Geiger zone at CO_2 concentrations over 5×10^{-4}. No processes other than the photoelectric one have been found to be efficient in counters filled with A + CO_2 mixtures up to a concentration of 5×10^{-3}. At higher percentages the photoelectric process is considerably reduced; there has been found to be effective in the discharge build-up a process by which electrons are released in the gas body. The counter behaves as a regular fast counter. The effect of mercury vapour in the discharge in pure A is also described; it is accounted for by the well-known Penning process of Hg ionization by collision on excited A atoms. This process causes the discharge to start at extremely low multiplication values. A.

537.542

919. Proportional fission neutron counters. R. C. ROHR, E. R. ROHRER AND R. L. MACKLIN. *Rev. sci. Instrum.*, **23**, 595–8 (*Nov.*, 1952).

Several proportional fission neutron counters are described which use a uranium compound as the neutron-sensitive material coated on the inside surface of the cathode. The counters are filled with high purity argon gas which produces very fast, clean pulses. The instruments use a discriminator circuit which eliminates the α-pulses from the uranium and also makes the instrument insensitive to γ-rays. A portable circuit has been developed consisting of two inverters, a discriminator and a multivibrator. Subminiature tubes are used because of their small size, low current drain and relatively high amplification factor. A laboratory model of the slow neutron instrument had an efficiency of 0·01% for polonium beryllium neutrons. A.

537.542

920. Scintillation counting techniques. H. KALLMANN, M. FURST AND M. SIDRAN. *Nucleonics*, **10**, 15–17 (*Sept.*, 1952).

A short account of the use of scintillation counters, including the storage-type phosphors, for the measurement of gamma-radiation dosage. A table of the integrated light outputs of a large number of solid and liquid scintillation materials irradiated by a radium source is given. L. R. SHEPHERD

537.542

921. Liquid scintillation beta counter for radioactive solids. O. BLÜH AND F. TERENTIUK. *Nucleonics*, **10**, 48–51 (*Sept.*, 1952).

The counter described utilizes two end-cathode type

photomultipliers operating in coincidence. One of the photomultipliers is mounted cathode upwards with a beaker cemented on to the glass face. The beaker is filled with a terphenyl-toluene solution into which the cathode end of the second multiplier dips. The radioactive material is coated thinly on cellophane, several layers of which are mounted in the phosphor between the multiplier cathodes. In an alternative arrangement the solid radioactive substance is mixed into a paste with the liquid phosphor. The latter arrangement gave counting efficiencies up to 50% with high-energy β-particles from KCl but only about 1% with C^{14} β-particles. L. R. SHEPHERD

537.542

922. Combination peaks: an energy addition effect in scintillation counters. P. S. JASTRAM, J. A. WHALEN AND O. H. ZINKE. Letter in *Rev. sci. Instrum.*, **23**, 648–9 (*Nov.*, 1952).

Simultaneous scintillations produced by different processes (e.g. annihilation radiation and Compton encounters) will add to produce a large energy peak in the recorded distribution. Precautions necessary to distinguish such effects are described.

G. F. J. GARLICK

537.542 : 621.387.464

923. High-energy particles and the scintillation counter. L. F. WOUTERS. *Nucleonics*, **10**, 48–52 (*Aug.*, 1952).

The advantages of scintillation counters over G–M or proportional counters in detecting the high-energy particles from modern accelerators are discussed. The behaviour of organic phosphors with high-energy protons and mesons are described and the main requirements in the design of the scintillation detectors are outlined. High-speed circuit techniques involved in the use of scintillation counters as high-energy particle detectors are discussed.

L. R. SHEPHERD

537.542 : 621.387.462

924. The phosphor-phototube radiation detector. D. P. COLE, P. A. DUFFY, M. E. HAYES, W. S. LUSBY AND E. L. WEBB. *Elect. Engng*, **71**, 935–9 (*Oct.*, 1952).

A compact instrument comprising fluorescent crystal, photomultiplier and amplifier is described for γ-ray measurements over the range 0·1 to 500 r/hr. Anthracene with small added crystals of $CdWO_4$ gives a uniform response within ±15% for energies between 0·08 and 2 MeV and an Sr90 source with light shutter provides a calibration standard in the presence of radiation. [illegible] (R)

537.542

925. A simple automatic counter. G. A. SHIRN AND E. S. WAJDA. *Nucleonics*, **10**, 30–1 (*Sept.*, 1952).

The counting system employs a G.M. tube, which moves on a travelling carriage, stopping successively over a series of sample and background counting positions. The counting tube output is fed through a scaling unit to individual registers, each corresponding to a given sample or background count. Details of the timing control and switching sequence are given. In the equipment described there are eight sample counting positions each separated by adequate lead shielding. L. R. SHEPHERD

537.542

926. An automatic counter for age determination by the C^{14} method. H. R. CRANE AND E. W. MCDANIEL. *Science*, **116**, 342–7 (*Oct.* 3, 1952).

The counter has an outer steel envelope (61 in. long, 3¾ in. i.d.) containing three iron cylinders (each 9 in. long, 3¼ in. i.d.) on which samples may be coated. A lead screw moves the cylinders so that, one at a time, they form the counter cathode. An unknown carbon sample may thus be alternated frequently with a contemporary and a dead sample, all operations being automatically timed by a clock and relay system. Constructional details of the counter and its iron shield are given, and the effects of choice of materials and of airborne radioactivity on the background counting rate are discussed. A dead-time of 15 msec suppresses spurious counts, and stable operation is ensured by automatic regulation of counter voltage according to pulse size. A (corrected) counting rate of 0·0142 c.p.m./cm² is quoted for a thick contemporary carbon sample. J. J. WILKINS

537.542 : 621.316.7 : 621.387.424

927. A circuit for the limitation of discharge in G-M counters. W. C. PORTER AND W. E. RAMSEY. *J. Franklin Inst.*, **254**, 153–64 (*Aug.*, 1952).

A simple two-tube feedback arrangement to limit the discharge in a counter to a small segment of its length, subsequently restoring all but a small portion of the tube to full sensitivity in about 1 μsec, has been achieved. A marked reduction in dead-time, and a correspondingly large increase in life result. For example, a 20 cm counter may be operated at a rate of 20 000 counts/sec with a loss no greater than that normally encountered at 1000 counts/sec. Counting rate data are given along with studies of the discharge distribution with and without the cut-off procedure. Alteration in the dead-time picture is illustrated by oscillograms. A.

537.542 : 621.318.572

928. Pulse-amplitude analysis in nuclear research. II. A. B. VAN RENNES. *Nucleonics*, **10**, 22–8 (*Aug.*, 1952).

For Pt I, see Abstr. 8911 (1952). The principles of single-channel differential pulse-height analysers, including the use of expander amplifiers preceding the discriminators to improve window width stability, are discussed briefly. The circuits and performance of three single-channel analysers are described in some detail. L. R. SHEPHERD

537.542 : 621.318.572

929. Pulse-amplitude analysis in nuclear research. III. A. B. VAN RENNES. *Nucleonics*, **10**, 32–8 (*Sept.*, 1952).

A number of different types of multichannel analysers are described. These include a mechanical kicksorter in which a steel ball is ejected on to a sloping plane, with an initial kinetic energy proportional to the pulse amplitude, and rolls into a collecting channel appropriate to that energy; a six-channel analyser employing diode discriminators; a five-channel analyser utilizing a sorting ladder and

beam-deflection type analysers. The performance of the beam-deflection analyser is compared with that obtained by more conventional methods of discrimination. L. R. SHEPHERD

537.542 : 621.387.464 : 621.383.27

930. Two new photomultipliers for scintillation counting. M. H. GREENBLATT, M. W. GREEN, P. W. DAVISON AND G. A. MORTON. *Nucleonics*, **10**, 44–7 (*Aug.*, 1952).

The type H-5037 photomultiplier is designed for efficient light collection with very large crystals. It has a large uniform cesiated-antimony photo-cathode of 9·6 in² working area and an electron optical system to direct the electrons from this cathode on to the first dynode of the multiplier which is of the 931 type. The type 4646 photomultiplier employs 16 dynodes to give a gain of 10^9, thereby eliminating the need for conventional amplifiers. The efficiency of collection of the photoelectrons is 95–100%. Particular attention has been devoted in the design of the anode system to prevent space-charge current limitation, arising from the use of such a high gain. The 4646 anode system is designed to deliver 200 mA without space-charge limitation. L. R. SHEPHERD

537.542

931. Thermocouple temperatures in a diffusion cloud chamber. H. L. MORRISON AND G. J. PLAIN. *Rev. sci. Instrum.*, **23**, 607–9 (*Nov.*, 1952).

The radial and vertical thermocouple temperatures in a cylindrical diffusion cloud chamber have been measured during operation, using copper-constantan thermocouples supported by a light Bakelite framework. Readings were taken at regular time intervals, beginning with the addition of the solid CO_2, through thermal "equilibrium," and until the chamber had ceased to operate upon the depletion of the refrigerant. The vertical thermocouple temperature gradient in the sensitive volume (the lower one-third of the chamber) was found to be approximately 13°C/cm. The addition of heat to the top of the chamber had negligible effect on the vertical gradient in the bottom third of the chamber and hence changed the depth of the sensitive volume only slightly. There appeared to be no appreciable horizontal gradient. A.

IONIZATION . THERMIONICS 537.56/.58

537.56/.57

932. The density effect for the ionization loss in various materials. R. M. STERNHEIMER. *Phys. Rev.*, **88**, 851–9 (*Nov.* 15, 1952).

The density effect for the ionization loss of charged particles has been calculated for a number of metals, scintillating materials, gases at various pressures, and photographic emulsion, using a dispersion model involving an appropriate number of dispersion oscillators for each substance. The results are presented in the form of graphs which can be used to correct the ionization loss for the density effect. The theoretical curves for silver chloride and anthracene are in reasonable agreement with experiments on the ionization loss of μ-mesons. A general derivation of the equations for the density effect is given. A.

537.564

933. Energy expenditure per ion pair for electrons and α-particles. J. M. VALENTINE AND S. C. CURRAN. *Phil. Mag.*, **43**, 964–7 (*Sept.*, 1952).

Work on the energy expenditure per ion pair, V, by means of end-corrected ion chambers and proportional counters is extended to include ionization by Po α-particles. The gases A, He, H, N, air, O and methane are studied. Curves of ion current against percentage of A admixed with the other gases are plotted and the ratio V gas/V A determined in each case. Previous values of V obtained with electrons are discussed and small differences in the corresponding values of V in the electron and α-particle cases are noted. A.

537.564

934. Energy per ion pair for argon with small admixture of other gases. J. SHARPE. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 859–60 (*Oct.*, 1952).

Gives data, with a brief discussion of the interesting case of A/CO_2, for the average energy necessary to form an ion pair derived from α-particle absorption measurements. Gases studied were: A, air, O_2, N_2, CH_4, CO_2 and (A + 5% CO_2). J. D. CRAGGS

537.565

935. Measurement of the mobility of electrons in oxygen and of their probability of fixation on the molecules of this gas. P. HERRENG. *Cahiers de Phys.*, *No.* 38, 6–16 (*July*, 1952) *In French.*

The displacement current of ions produced, in the interior of the gas, by very brief periodic X-ray impulses is observed. This allows a direct measurement to be made of the electron mobility and of the probability h of an electron becoming fixed on a gas molecule. An attempt is made to explain the observed maximum of h near 2 V. J. JACOBS

537.568

936. The deionization and striking potential of a rarefied gas with residual ionization. S. I. ARDONOVA. *Zh. tekh. Fiz.*, **22**, *No.* 6, 981–8 (1952) *In Russian.*

Investigation of the deionization process in A, Kr, Ne and Hg vapour in the pressure range from a few tens to a thousand μ (Hg), in a special 52 mm dia. tube. Ionization was produced by a 2 Mc/s electrodeless discharge at a 50 c/s recurrency frequency, and the process followed visually by c.r.t. Experiment (confirmed by theory) showed that deionization proceeded in the inert gases exponentially, in the Hg vapour at first exponentially, but more slowly towards the end of the process; the time constant of fall of electron temperature being in all cases large in relation to the time constant of deionization. Some data on restriking potentials are given. A 10^{-5} cm quartz film condensed on to an electrode reduced the restriking potential 40–50%. F. QUELON

537.583

937. Thermionic constants of the iron group of metals. K. S. KRISHNAN AND S. C. JAIN. Letter in *Nature* [*London*] **170**, 759 (*Nov.* 1, 1952).

Results were obtained by the saturation vapour

pressure method [Abstr. 5869 (1952)]. The following results are given:

	ϕ (eV)	A (amp/cm/deg.)
Chromium	4·58 ± 0·02	60 ± 2
γ-iron	4·31 ± 0·02	60 ± 2
Cobalt	4·41 ± 0·02	60 ± 2
Nickel	4·50 ± 0·02	120 ± 5
Titanium	3·95	44
Vanadium	4·12	50
Manganese	3·83	34

A. H. W. BECK

537.583

938. Poisoning of oxide cathode emission by oxygen. A. A. SHEPHERD. Letter in *Nature* [*London*] **170**, 839–40 (*Nov.* 15, 1952).

Cathodes were poisoned with O_2 in a mass spectrometer, the poisoning being reversible, the emission of O^- ions increased by a factor of 10 when recovery commenced. The ions were predominantly of mass 16. Reactivation increased with increasing potential gradient in the coating. Further experiments were made with diodes which had probes embedded in their cathodes. These gave a variation of conductivity with temperature of the type observed by Loosjes and Vink and when oxygen was admitted the high temperature conductivity was poisoned in the same way as the emission, while the low temperature (below 700°K) conductivity was constant. It is concluded that oxygen poisoning is due to adsorption both on the outer cathode surface and interior crystallite surfaces. A. H. W. BECK

537.583

939. Neutralization of potassium and sodium ions on tungsten and tantalum. L. N. DOBRETSOV, V. N. LEPESHINSKAYA AND I. E. BRONSHTEĬN. *Zh. tekh. Fiz.*, **22**, *No.* 6, 961–7 (1952) *In Russian.*

The neutralization of K ions at temperatures < 900°K is characterized by an ionization coefficient substantially lower than that determined by Langmuir and Saha's equations (β_0). For $T > 1200$°K the ionization coefficient $\sim$ the theoretical value. In the whole temperature range β increases with increasing energy of the incident ions. For Na the measured value of $\beta > \beta_0$ of the Langmuir–Saha equations in the whole temperature range. It has a maximum between 800° and 1500°K. At high temperatures β increases with the ion energy E_p. For K on Ta $\beta = f(T)$ is analogous to the temperature relation for Na on W, although the difference between β and β_0 is much smaller. A theoretical explanation of these relations is presented. B. F. KRAUS

537.583 : 536.53 : 621.385.2.032.216 : 621.317.39

940. Electrical measurement of the cathode temperature of diodes. D. A. BELL, J. C. CLULEY AND H. O. BERKTAY. *Brit. J. appl. Phys.*, **3**, 322–3 (*Oct.*, 1952).

Comparison of "electrical" and pyrometric temperature for several different types of diode show that the electrical method can be reliably used with oxide-coated cathodes. The method may be of use in determining the surface temperature of indirectly-heated cathodes in practical valve structures which are not accessible for pyrometric measurements. A.

COSMIC RAYS 537.591

537.591.1

941. The electronic component at low altitudes produced by π-meson decay. E. D. PALMATIER. *Phys. Rev.*, **88**, 761–72 (*Nov.* 15 1952).,

The intensity of the electronic component at low altitudes produced by π-meson decay (designated as the E_π component) has been obtained as a function of zenith angle and altitude by subtracting from the experimentally observed soft component those electrons arising from the collision and decay processes of μ-mesons (designated as E_μ electrons). Extensive auxiliary studies of the corrections required in such soft component studies are described, and experimental requirements are stated for a precise telescopic study of the soft component. In particular it is shown that the usual method of correcting a Geiger counter telescope for side showers is incorrect, and also that the effect of wall-generated secondaries should be considered. It is shown that the E_π component of energy greater than 30 MeV can be represented as a function of zenith angle θ and atmospheric depth h by the expression $I(E_\pi, h, \theta) = 0{\cdot}70 \exp(-h/160 \cos\theta)$ cm^{-2} sec^{-1} sterad^{-1}, for $\theta \leqslant 60°$ and $h \geqslant 700$ g cm^{-2}. A.

537.591.1

942. Range distribution of sea-level mesons at low geomagnetic latitudes. L. DEL ROSARIO AND J. DÁVILA-APONTE. *Phys. Rev.*, **88**, 998–1002 (*Dec.* 1, 1952).

Seven points of the meson differential spectrum at sea level have been obtained at a geomagnetic latitude of 29°N. The method used was that of delayed coincidences and anticoincidences, and the range interval covered has been from about 10 to 320 g/cm^2 of air equivalent. In this interval the spectrum curve is found to be nearly flat; that is, it does not show a clear maximum around 200 g/cm^2 air equivalent, as indicated by several authors working at geomagnetic latitudes around 45°N. A.

537.591.15

943. Local penetrating showers from water and carbon. C. B. A. MCCUSKER AND D. D. MILLAR. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 758 (*Sept.*, 1952).

Frequency of showers observed in a cloud chamber under 90 cm water has been compared with that under carbon. A twofold coincidence from each of two counter trays was required to trigger the chamber. One tray was placed immediately beneath the transition material and the other in a lead pile beneath the chamber. Extensive showers were eliminated by disregarding events in which a third counter tray 1·5 m away was also discharged. The average multiplicity of penetrating particles was found to be 2·25 ± 0·13 for carbon and 2·16 ± 0·13 for water. Assuming geometric interaction cross-sections the average multiplicity from hydrogen was estimated as 1·88 ± 0·68. H. ELLIOT

537.591.15

944. Plural theories for the shower component in high energy nuclear disintegrations. H. MESSEL AND R. B. POTTS. *Phys. Rev.*, **88**, 488–92 (*Nov.* 1, 1952).

Detailed numerical results are presented for the average numbers of protons and mesons emitted as

shower particles in high-energy nuclear disintegrations. The results for two schemes of plural production of mesons are compared with results previously obtained [Abstr. 6608 (1952)] using the Heitler–Janossy(1) model in which it was assumed that the nucleus is transparent to the mesons emitted in the individual nucleon-nucleon collisions. It is concluded that this latter model best fits the limited experimental data available. The results presented for mesons are based on the assumption that the shower particles consist of π-mesons and protons only. This assumption is not essential, as the energy going into the meson component could be considered as producing meson of various types. Some recent criticisms of the cascade theory are also answered. A.

537.591.8

945. On the origin of single tracks with high grain density caused by cosmic rays in photographic plates. H. Garski. *Z. Naturforsch.*, **7a**, 565–70 (*Aug.*, 1952) *In German.*

Within the experimental error (20%) the number of protons and heavy particles coming to rest in the emulsion equals the number starting there of which 60% are from stars. Work on angular correlation is also described, and continues. F. R. HOLT

537.591.8 : 539.172

946. The energy distribution of alpha-particles emitted from nuclear disintegrations. P. E. Hodgson. *Phil. Mag.*, **43**, 934–41 (*Sept.*, 1952).

The energy distributions of the α-particles emitted from small nuclear disintegrations caused by the cosmic radiation in photographic emulsion have been found. These are analysed into the parts due to the light and the heavy elements of the emulsion, and the variation of nuclear temperature and effective potential barrier height with star size found for each. A.

537.591.8

947. Energy loss of cosmic ray mu-mesons in sodium iodide crystals. A. Hudson and R. Hofstadter. *Phys. Rev.*, **88**, 589–96 (*Nov.* 1, 1952).

A scintillation counter telescope, employing three NaI(Tl) crystals in coincidence, has been used to study the energy losses experienced by μ-mesons in traversing one of the crystals. The magnitude of the light flash in NaI(Tl) has been assumed to be proportional to the energy lost in the crystal by the meson. The observed pulse distribution is compared with one calculated on the basis of the Bethe–Bloch theory without the density correction and also with the Halpern–Hall theory which includes the effect of the dielectric shielding. Each calculated curve employs a fold of the Landau straggling theory with the cosmic-ray μ-meson spectrum. Comparison of the data with the two theories definitely favours the Halpern–Hall theory both in respect to absolute value of the most probable energy loss as well as the shape of the distribution. A.

MAGNETISM 538

538.082 : 541.183

948. An apparatus for the simultaneous determination of adsorption isotherms and magnetic susceptibility. W. O. Milligan and H. B. Whitehurst. *Rev. sci. Instrum.*, **23**, 618–20 (*Nov.*, 1952).

An apparatus is described for the simultaneous determination of adsorption isotherms and magnetic susceptibility. A fused silica spring with a sensitivity of 3 mm/mg is used to determine adsorption gravimetrically in the manner of McBain and Bakr. An electromagnet is incorporated in the apparatus to allow the determination of the magnetic susceptibility of the sample and the adsorbed vapour by the Faraday method. The apparent change in weight caused by the inhomogeneous magnetic field is $11{\cdot}46\times10^3$ times the sample weight for a substance of unit magnetic susceptibility (c.g.s. units). The same spring is used for the measurement of adsorption and magnetic susceptibility, and both measurements are made on the same sample. A.

538.112

949. Number theory and the magnetic properties of an electron gas. M. F. M. Osborne. *Phys. Rev.*, **88**, 438–51 (*Nov.* 1, 1952).

Theorems involving the correction terms of lattice point problems in the theory of numbers are interpreted to derive the orders of magnitude of the oscillatory (de Haas–van Alphen effect) and non-oscillatory (Landau and surface diamagnetism) terms in the magnetic moment of a Fermi gas in a finite cylindrical container. The results are valid for systems from atomic dimensions up, and all values of the magnetic field. The different types of moment are different from strong and weak fields, and may depend, for small particles, on the nature of the surface potential at the walls of the container. The applicability of the method to physical problems, and the difficulties associated with statistical mechanical problems involving magnetic fields are discussed. A.

538.112

950. Application of the theory of numbers to the magnetic properties of a free electron gas. M. C. Steele. *Phys. Rev.*, **88**, 451–64 (*Nov.* 1, 1952).

The methods of number theory are used to find the magnetic properties of a free electron gas. The mathematical procedure which connects number theory to quantum mechanics is given in detail since the same or a similar method may be useful in other problems of solid state and nuclear physics. The magnetic moment calculation is given in three parts. For the case in which surface states are not considered the results obtained are in agreement with those of previous workers. But when the use of a finite container (rectangular box) to hold the electrons is considered, it is no longer possible to neglect surface states. Through the use of the W.K.B. approximation it is found that the surface states give rise to new size-dependent terms in both the oscillatory and non-oscillatory parts of the magnetic moment. The oscillatory corrections are generally negligible compared to the usual de Haas–van Alphen effect. However, the nonoscillatory correction, which is diamagnetic in character, can be larger than the Landau diamagnetism for properly chosen magnetic field strengths and container sizes. The calculation is concluded with a consideration of the effect of the electron spin. It is found, in agreement with other

workers, that the only effect of spin on the oscillatory part of the magnetic moment is to introduce a phase change of $\pm\pi$ in alternate terms. The "surface" diamagnetic correction due to a finite container is found to be independent of electron spin. Details on the use of the method of critical points of evaluating integrals asymptotically are given in the appendix. A.

538.114

951. The theory of ferromagnetism and the Heisenberg model. J. YVON. Letter in *J. Phys. Radium*, **13**, 488–9 (*Oct.*, 1952) *In French.*

Gives preliminary results of a quantum statistical treatment of ferromagnetism equivalent to the Bethe approximation in the treatment of order-disorder phenomena. Values of the ratio J/kT_c are given for a number of values of the number of nearest neighbours and for $S = \frac{1}{2}$, 1, J being the exchange integral and T_c the Curie temperature. Comparison is made with the results of calculations by Weiss.

E. P. WOHLFARTH

538.114

952. Spherical model of a ferromagnet. H. W. LEWIS AND G. H. WANNIER. Letter in *Phys. Rev.*, **88**, 682 (*Nov.* 1, 1952).

Shows that the statistical mechanical treatment of co-operative phenomena in crystals given by Berlin and Kac [Abstr. 6615 (1952)] can be simplified by the use of a grand rather than a canonical ensemble.

E. P. WOHLFARTH

538.114

953. Spin-spin relaxation in ferromagnetic resonance. F. KEFFER. Letter in *Phys. Rev.*, **88**, 686 (*Nov.* 1, 1952).

Shows that it is theoretically possible that the line width in ferromagnetic resonance spectra is finite at 0°K, due to the influence of zero-point fluctuations of spin-spin magnetic dipole forces. E. P. WOHLFARTH

538.114 : 539.11

954. The theory of the saturation magnetization of binary ferromagnetic alloys. H. STATZ. *Z. Naturforsch.*, **7a**, 506–11 (*Aug.*, 1952) *In German.*

An investigation of the electronic structure of some ferromagnetic alloys of Ni and of Fe and the relation to the magnitude of the saturation magnetization. It is shown on the basis of the tight binding approximation that in body-centred cubic crystals the atomic 3*d* level splits into two narrow and three lower-lying wide energy bands. On assuming a certain amount of band overlap the so-called Pauling curve is explicable on energetic grounds. E. P. WOHLFARTH

538.123 : 621.318.572 : 621.395.625.3 : 621.3.011

955. On two problems in potential theory and their application to the design of magnetic recording heads for digital computers. A. D. BOOTH. *Brit. J. appl. Phys.*, **3**, 307–8 (*Oct.*, 1952).

An examination of two sets of examples shows that the external field arising from the gap in a magnetic digit recording head is very insensitive to the pole-piece shape. It follows that head design should be decided by facility of manufacture rather than by theoretical perfection. A.

538.22

956. Magnetic susceptibilities of palladium-rhodium alloys from 20° to 300°K. F. E. HOARE, J. S. KOUVELITES AND J. C. MATTHEWS. Letter in *Nature* [*London*] **170**, 537–8 (*Sept.* 27, 1952).

Results for alloys with up to 10% rhodium are presented diagrammatically. On first diluting palladium the susceptibility increases, but this is reversed for higher rhodium content. The values for pure palladium and one palladium-silver alloy are also given. F. E. HOARE

538.221/.222

957. Effective magnetic distances in ferromagnetic and antiferromagnetic metals, alloys and compounds of the iron group. R. FORRER. *Ann. Phys.* [*Paris*] **7**, 605–21 (*Sept.–Oct.*, 1952) *In French.*

A compilation. It is shown that in these substances there are well-defined ranges of the distance between the magnetically effective atoms for which the substances exhibit ferromagnetism, antiferromagnetism or paramagnetism. E. P. WOHLFARTH

538.221

958. Spontaneous magnetization of ferrites. R. PAUTHENET. *Ann. Phys.* [*Paris*] **7**, 710–47 (*Sept.–Oct.*, 1952) *In French.*

Describes measurements of the temperature variation of the spontaneous magnetization of Mn, Fe, Co and Ni ferrites between 20°K and the Curie point, and interprets the results on the basis of Néel's treatment, using values of the molecular field coefficient derived from paramagnetic data. The variation of the saturation magnetization of Cu and Mg ferrites and of mixed Ni–Zn ferrites was investigated and the influence of heat treatment on the results examined experimentally and theoretically (ionic redistribution between A and B lattice sites).

E. P. WOHLFARTH

538.221

959. Ferromagnetism at very high frequencies. IV. Temperature dependence of the magnetic spectrum of a ferrite. G. T. RADO, R. W. WRIGHT, W. H. EMERSON AND A. TERRIS. *Phys. Rev.*, **88**, 909–15 (*Nov.* 15, 1952).

For Pt III, see Abstr. 1178 (1951). The magnetic spectrum of a sintered ferrite, previously studied by the authors at room temperature and found to contain an r.f. resonance, attributed to domain wall displacements, and a microwave resonance, attributed to domain rotations, has now been observed at 77°K, 195°K and 411°K. By using single-domain particles of this material embedded in wax, the rotational resonance was observed separately. The principal aspect of the experimental results is the fact that with increasing temperature the resonance frequencies decrease, the fractional change being about the same in all three cases and exceeding that of the saturation magnetization. A semiquantitative theoretical interpretation of this fact is given. Auxiliary experiments, performed as an aid in interpreting the magnetic spectrum, include measurements of the spectroscopic splitting factor g at various temperatures. The deviation of the apparent g factor values from $g = 2$, as well as their temperature dependence, was found to decrease with increasing resonance field, i.e. increasing resonance frequency. A.

538.221

960. The parallel susceptibility of an antiferromagnet at low temperatures. J. R. TESSMAN. *Phys. Rev.*, **88**, 1132–7 (*Dec.* 1, 1952).

The spin wave method of Heller and Kramers is applied to a cubic antiferromagnetic crystal, oriented so that the direction of alignment of the sublattice spins is parallel to an external magnetic field. Taking into account exchange interactions and an anisotropy term, then the parallel susceptibility χ_{II} is zero at $T = 0°K$, in agreement with the result of the molecular field treatment of the problem by Van Vleck. If nearest neighbour magnetic dipole interactions are included, χ_{II} is nonzero but negligibly small: $\chi_{II} \sim 10^{-11}$ at $T = 0°K$. For $T > 0$ but much less than the antiferromagnetic Curie temperature, if the dipole interactions are neglected and the anisotropy is small, such that $\zeta = S(24JK)^{\frac{1}{2}}/kT \ll 1$, where K is an anisotropy constant, then $\chi_{II} \propto T^2$. If $\zeta \gg 1$, then $\chi_{II} \propto T^{\frac{1}{2}} \exp[-S(24JK)^{\frac{1}{2}}/kT]$. A.

538.221

961. Ferromagnetic properties of hexagonal iron-oxide compounds with and without preferred orientation. G. W. RATHENAU, J. SMIT AND A. L. STUYTS. *Z. Phys.*, **133**, *No.* 1–2, 250–60 (1952).

See Abstr. 6627 (1952). A discussion of the characteristics of the magnetization curve of Ferroxdure, $BaO.6Fe_2O_3$. It is shown that the coercive force is not due solely to the presence of small ferromagnetic particles having magnetocrystalline anisotropy. The formation of Bloch walls is considered and it is concluded that they are formed at points of irregularity in the material, for example at grain boundaries. The shape of the magnetization curve is discussed for materials with large or small grains, considering pure rotation or pure wall movement to be the process of magnetization; in the former case comparison is possible with theoretical curves due to Stoner and Wohlfarth [Abstr. 1877 (1948)]. Methods of increasing the energy product $(BH)_{max}$ by producing preferred orientation of the hexagonal axes are described. The improvement of the texture due to grain growth is discussed. E. P. WOHLFARTH

538.221

962. Preferred crystal orientation in ferromagnetic ceramics. A. L. STUYTS, G. W. RATHENAU AND E. W. GORTER. Letter in *J. appl. Phys.*, **23**, 1282 (*Nov.*, 1952).

Grain orientation in a magnetic field prior to sintering produces an increase of $(BH)_{max}$ from 1 to 3×10^6 in $BaO.6Fe_2O_3$; the texture is improved by grain growth. See also preceding abstract.

E. P. WOHLFARTH

538.221 : 538.24 : 550.38

963. Reverse thermo-remanent magnetism. T. NAGATA, S. AKIMOTO AND S. UYEDA. *Proc. Japan Acad.*, **27**, 643–5 (*Dec.*, 1951).

Gives a more detailed account of investigations on igneous rocks previously summarized [Abstr. 5192 (1952)]. E. P. WOHLFARTH

538.221 : 538.24 : 550.38

964. Reverse thermo-remanent magnetism. II. T. NAGATA, S. AKIMOTO AND S. UYEDA. *Proc. Japan Acad.*, **28**, 277–81 (*June*, 1952).

See preceding abstract. Reports investigations of the properties of the ferromagnetic grains present in the igneous rocks and responsible for the phenomenon under discussion. Measurements were carried out by cooling and reheating the specimens between two temperatures in an applied field and measuring the magnetization I at different temperatures T. Curves of I against T are given and show the development and disappearance of thermo-remanent magnetization of either sign. The phenomenon is partially interpreted on the basis of theoretical investigations by Néel [Abstr. 8368 (1951), 6912 (1952)]. E. P. WOHLFARTH

538.221 : 681.84 : 621.318.1 : 621.395.625.3

965. Experiments on magnetic anisotropy in magnetic-recording tapes. J. GREINER. *Nachrichtentechnik*, **2**, 197–201 (*July*, 1952) *In German.*

Magnetic anisotropy in ferromagnetic materials is mainly dependent upon particle shape and the degree of orderly arrangement of the particles, since demagnetization is in turn dependent upon these factors. Whether spherical or acicular particles are employed, the most pronounced anisotropy appears when the individual particles form chains whose direction coincides with the natural magnetic axes of the particles. To investigate the possibilities of chain formation and its effects, remanence tests were carried out on samples of magnetic tape using a magnetizing coil, from which the sample could be withdrawn, and a search coil and galvanometer. The tests consisted in comparing the remanence curves and hysteresis loops of samples magnetized by the coil (*a*) in the direction of coating, and (*b*) normal to it. Corrections were applied, from comparison of saturation values, where the (*b*) samples had to be prepared by cutting them out from a row or normal $\frac{1}{4}$ in. strips stuck down side by side on an adhesive base. Two types of tapes were tested in this way, one of which showed no anisotropy, the other ~12%, although from chemical, spectroanalytic and X-ray grating tests, the magnetic material was γ–Fe_2O_3 in both cases. To test whether the anisotropy arose from chain formation caused by magnetic orientation, ten measuring tubes 60 cm long, 7×7 cm cross-section, were filled with γ–Fe_2O_3 dispersion and allowed to dry while subjected to constant magnetic fields of various strengths. Remanence curves subsequently plotted showed an increase in remanence of the aligned over the unaligned columns, rising as the aligning field rose from 0 to 500 oersteds.

H. G. M. SPRATT

538.222

966. Coupling between magnetic moments in molecules containing three iron atoms. B. TSAÏ AND J. WUCHER. Letter in *J. Phys. Radium*, **13**, 485–6 (*Oct.*, 1952) *In French.*

Extends earlier measurements of the susceptibility of ferric acetate and benzoate [Abstr. 2836 (1952)] down to 2°K and interprets the new data.

E. P. WOHLFARTH

538.222

967. Attempt to interpret the magnetic properties of certain molecules containing three iron atoms. A. ABRAGAM, J. HOROWITZ AND J. YVON. Letter in *J. Phys. Radium*, **13**, 489–90 (*Oct.*, 1952) *In French.*

A theoretical interpretation of the results obtained by Foëx *et al.* [Abstr. 2836 (1952) and preceding

abstract]. The spin Hamiltonian is modified by the inclusion of an anisotropic term and the experimental results interpreted by suitable choice of the parameter so introduced. E. P. WOHLFARTH

538.222

968. Paramagnetic resonance in potassium chromicyanide. K. D. BOWERS. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 860–1 (*Oct.*, 1952).

In a crystal containing chromium enriched in Cr^{53} a h.f.s. of 4 lines of equal intensity was clearly resolved below 90°K, confirming the value 3/2 for the spin of Cr^{53}. Comparison of the *A*-value with that for potassium vanadocyanide gives the nuclear magnetic moment as 0·58 n.m. L. PINCHERLE

538.222

969. Crystalline field in chrome alum. W. H. KLEINER. *J. chem. Phys.*, **20**, 1784–91 (*Nov.*, 1942).

A calculation is made to test the detailed applicability of the crystalline field approximation for describing magnetic properties of chrome alum. The theoretical susceptibility formula of Schlapp and Penney represents the experimental susceptibility as a function of temperature reasonably well provided the parameter *Dq*, which gives a measure of the interaction between the crystalline field and the paramagnetic ion, is arbitrarily chosen to give the best fit. Here *Dq* is calculated; a model of the surroundings of the Cr^{+++} ion is used to determine the crystalline field. The calculated *Dq* is in poor agreement with experimental values, from which it is inferred that the interaction between the Cr^{+++} ion and its surroundings is so strong that the crystalline field approximation is inadequate to give detailed agreement with experiment. The results are expected to apply to other hydrated paramagnetic salts of the iron group. A.

538.222

970. Spin paramagnetism of Cr^{+++}, Fe^{+++}, and Gd^{+++} at liquid helium temperatures and in strong magnetic fields. W. E. HENRY. *Phys. Rev.*, **88**, 559–62 (*Nov.* 1, 1952).

A quantitative experimental study of space quantization of magnetic dipoles and quenching of orbital angular momentum has been made by measuring the fractional variation of the magnetic moment of paramagnetic ions with magnetic field strength at fixed temperatures. The study of trivalent chromium ion ($^4F_{3/2}$ state for free ion) in potassium chromium alum up to 99·5% saturation at 1·29°K and in a field of 50 000 gauss gave a close confirmation of space quantization of magnetic dipoles through compatibility of experimental results with the Brillouin function and very marked incompatibility with the Langevin function. The quenching of orbital angular momentum by the crystalline electric field was demonstrated by the agreement of experimental measurements with a Brillouin function for $g = 2$ ($L = 0$) as against $g = 2/5$ ($L = 3$). The paramagnetic saturation of iron ($^6S_{5/2}$ for free ion) ammonium alum and gadolinium ($^8S_{7/2}$ for free ion) sulphate octahydrate was achieved, thus permitting of speculation as to a small contribution of the crystalline field to the magnetic moment. Some preliminary calculations were made of this effect for iron ammonium alum and compared with experiment. Experimental study of moments consisted in moving a spherical sample with respect to a double coil system and measuring the flux change ballistically. Magnetic moments were reproducible to ~0·2% in mid-range and the magnitude of H/T is known to ~1·5%. A.

538.222

971. Properties of the Cr^{+++} ion in the paramagnetic alums at low temperatures. R. P. HUDSON. *Phys. Rev.*, **88**, 570–2 (*Nov.* 1, 1952).

Formulae for the entropy and magnetic moment as functions of temperature and magnetic field are derived for the paramagnetic chromic alums at liquid helium temperatures, taking into account the Stark splitting of the magnetic energy levels by the electric field of the crystal lattice. A comparison is made between values of the magnetic moment derived therefrom and the results of recent experimental work on paramagnetic saturation in potassium chromic alum by Henry. A.

538.222

972. Paramagnetic resonance in phosphors. W. D. HERSHBERGER AND H. N. LEIFER. *Phys. Rev.*, **88**, 714–20 (*Nov.* 15, 1952).

Paramagnetic studies at 9375 Mc/s have been made on 32 inorganic phosphors containing paramagnetic activators. The sample is contained in a transmission cavity and the spectrum is obtained by a sweeping technique that yields the derivative of the absorption curve. Less than 10^{-11} mole of Mn^{++} may be detected in cubic host crystals. The specimen in the cavity may be illuminated by ultraviolet light for observations on changes in its spectrum under these conditions, but, when illuminated, the changes observed may be attributed largely to photoconduction. The phosphors containing Mn^{++} as an activator under no illumination yield a variety of spectra. Seven of these phosphors display a single absorption line 750 to 1000 gauss wide, while four phosphors with differerent host crystals but all having cubic symmetry display line spectra consisting of six lines seven gauss wide but with spacings between members of from 68 to 88 gauss depending on the host crystal. Finally, two phosphors display 30-line spectra which arise because the crystal field and the applied field together serve to remove both the *I* and *S* degeneracy, whereas for cubic crystals only the *I* degeneracy is removed. A.

538.224 : 535.218

973. Magnetic measurements on phototropic substances. F. DÖRR AND F. ENGELMANN. Note in *Naturwissenschaften*, **39**, *No.* 17, 397–8 (1952) *In German.*

Describes measurements at 90° and 290°K on powdered tetrachloride α-keto-naphthalene which has the property of changing its colour from white to violet after exposure to sunlight. It is concluded that the excited molecules are paramagnetic.

E. P. WOHLFARTH

538.24

974. The de Haas–van Alphen effect at high fields. D. SHOENBERG. *Nature* [*London*] **170**, 569–71 (*Oct.* 4, 1952).

A new method of studying the oscillatory field variation of magnetic susceptibility is described. A

magnetic field of nearly 10^5 gauss is produced impulsively by discharging a condenser through a liquid-air-cooled coil; the liquid-helium-cooled specimen is placed in the field in one of two pick-up coils which are connected in opposition, so that an e.m.f. is produced across the coils proportional to dI/dH and dH/dt. This e.m.f. is amplified and the oscillations of dI/dH are thus shown up on a c.r.o. The method is particularly suitable for oscillations of short period and such oscillations have been found in Pb. D. SHOENBERG

ELECTROMAGNETISM . ELECTRODYNAMICS
538.3/.5

538.3 : 530.15

975. Electromagnetic momentum and Newton's third law. E. G. CULLWICK. Letter in *Nature* [*London*] **170**, 425 (*Sept.* 6, 1952).

It is suggested that Newton's law is applicable to electromagnetic systems if account is taken of the mass of the field energy. R. A. NEWING

538.3 : 621.313.1

976. Electromagnetic field equation for low speed systems. J. ŘEZNÍČEK AND K. MALÝ. *Elektrotech. Obzor*, **41**, *No.* 3, 99–102 (1952) *In Czech.*

In an earlier paper J. Řezníček (1933) gave an approximate expression of the induction law in the form of a differential equation. The relation between this approximate formulation and the basic formulation is discussed, and it is proved that the approximate relation is valid only for solid bodies which cannot become electrically polarized or magnetized and move in a space free of isolated magnetic fields and provided that their speed of motion is low compared with the speed of light. To give the approximate and the fundamental relations the same meaning, certain relations have to be added to the fundamental equation, and these are given in the paper. E. GROS

538.55 : 621.3.013

977. Automodulation at ferro-resonance. A. E. SALOMONOVICH. *Zh. tekh. Fiz.*, **22**, *No.* 2, 245–58 (1952) *In Russian.*

A non-linearity, which is due to the dependence of the parameters upon the momentary values of oscillating variables and also, in some cases, to their dependence on the amplitudes of oscillating variables ("inertial" non-linearity), which characterizes electrical circuits containing coils with iron core, produces certain distinctive features in the resonance phenomena in these circuits, which justify classing them separately under the term "ferro-resonance." The inertial non-linearity is a necessary condition for periodic variation of the parameters known as "automodulation." Similar phenomena occur in other circuits with non-linear characteristics. Three examples are considered: (*a*) a circuit with a "thermistor," containing a source of a.c., a coil with an iron core, a condenser, and a resistance, all connected in series, (*b*) a circuit with a condenser filled with a dielectric whose constant depends on the field, e.g. $BaTiO_3$, and may also depend on the temperature, especially in the neighbourhood of the Curie point, (*c*) a circuit like (*a*), but with an electrostatic electrometer, connected in shunt, whose capacity is not insignificant. The analysis of circuit (*a*) is given in greater detail. It begins from a conventional differential equation for a.c. circuits, but with a third power correction term, in association with a conventional resistance-temperature formula for the case where the Joule heat is dissipated at a constant thermal conductance. The parameters are assumed to vary slowly in comparison with the harmonic oscillations. To facilitate the detection and elimination of the terms of smaller order of magnitude, the time variation of parameters is expressed in the form of a product of a small constant μ and a variable function. By eliminating small quantities of second order and higher, and a suitable change of variables, the initial two differential equations are converted into a simplified form. One of the two dependent variables, which these equations contain, is tentatively expressed in the form of a sum of two simple time harmonics in quadrature, with variable amplitudes expressed as functions of the "slow time" (i.e. time multiplied by μ). The other dependent variable is expressed in the form of an aperiodic function of the "slow time." On substituting these tentative expressions in the simplified differential equations, and eliminating the small quantities of second order and higher, three simultaneous differential equations of first order are obtained for the two amplitudes and the second dependent variable, as functions of the "slow time." The three dependent variables of this system are regarded as Cartesian co-ordinates in a representative three-dimensional space ("phase space," "configurations space"), and the first derivatives with respect to the "slow time" are regarded as the components of the velocity of the representative point in this space. The Cartesian co-ordinates are then changed to the cylindrical co-ordinates (ρ, θ, z), yielding the differential equations in the final form. It is shown that the other two examples, (*b*) and (*c*), lead to identical differential equations, by suitable change of variables. The stationary (i.e. time-periodic) solutions correspond to the points of representative space in which the velocity of representative point is zero. Therefore for the stationary solutions the three differential equations become simply algebraic equations, the roots of which determine the co-ordinates of the corresponding representative points. To determine the stability of stationary regimes, a matrix with 3^2 members representing the components of the acceleration of the representative point corresponding to this regime at the point of the representative space, in which a term $-S$, representing a virtual variation of acceleration, is added to each diagonal member. The "characteristic" equation for the stability, stating that the determinant of this matrix is zero, is a cubic equation with respect to S. The equations for the boundary lines of the stability areas in axial planes of the representative cylindrical space are obtained by using a theorem due to Gurvitz (1949) determining the values of the coefficients at different powers of S in this cubic equation. The author proceeds then to investigate a point in the representative space, corresponding to an unstable equilibrium, and investigate the conditions at which the representative point would follow a closed curve

in the representative space, eventually returning to the original position, and so repeating the process indefinitely. This will correspond to the auto-modulation. The results of this investigation are illustrated by a number of diagrams. At the end of the article, the author points out that the method is inapplicable to transistors with a large constant component of magnetization, because it is based on the assumption of only a small degree of non-linearity.

N. S. JAPOLSKY

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56 : 621.3.013

978. Impulse electromagnetic fields. R. KITAI. *Trans S. African Inst. Elect. Engrs*, **43**, 200–11 (*July*, 1952).

Expressions are developed for the fields established by the Hertzian dipole and by the magnetic dipole in terms of dipole moments. The expressions hold when the derivatives of the dipole moments are continuous for all values of time. It is then assumed that the moment M obeys a hyperbolic tangent law $M \propto \tanh(kt)$ and an insight into the nature of impulsive fields is obtained by considering the condition $k \to \infty$ when the function becomes a step. General expressions for impulse fields are then formulated, and an example is worked to illustrate some properties of impulse fields. It is found that the "static," "induction" and "radiation" fields have different shapes. Theory also shows that it is meaningless to consider the relative importance of these fields unless a receiver frequency is specified. A.

538.561 : 523.72

Plasma oscillations and solar "enhanced radiation." *See Abstr.* 583

538.566

979. The role of the requirement of outgoing radiation for a complex wave number and its significance for the surface wave problem. A. HAUG. *Z. Naturforsch.*, **7a**, 501–5 (*Aug.*, 1952) *In German.*

It is shown that Sommerfeld's requirement of the absence of converging radiation ensures the uniqueness of the solution of the wave equation $\Delta u + k^2 u = 0$ in a uniform medium also for complex k. This can be extended to 2 semi-infinite regions and it follows that Sommerfeld's surface wave is not inconsistent with the above requirement. W. J. SWIATECKI

538.566

980. Short-wave radiation phenomena. Volumes I and II. A. HUND. *New York, London: McGraw-Hill* (1952) 1382 *pp.*

Review in *Science*, **116**, 33–4 (*Sept.* 26, 1952).

538.566

981. Diffraction of electromagnetic waves by an orifice in a conducting screen. J.-P. VASSEUR. *Ann. Phys.* [*Paris*] **7**, 506–63 (*July–Aug.*, 1952) *In French.*

After a preliminary study of earlier work, rigorous integral equations are developed for the calculation of the diffraction pattern due to an orifice in a conducting screen. In applying Huyghen's ideas, electrical and magnetic dipoles are taken as "elementary sources," and two complementary distributions of these sources are proposed, over either the orifice or the screen. Reciprocal formulae are also given for diffraction by an obstacle. The equations can only be solved explicitly for simple cases, and these have been checked by experiments on the diffraction of microwaves, e.g. the axial diffraction pattern of a circular hole has been found to be accurately given by the formulae. More complicated cases, e.g. diffraction at an opening in a circular waveguide, could possibly be treated with the aid of numerical solutions to the equations. D. G. AVERY

538.566 534.26

Diffraction of an electromagnetic pulse by a right-angled wedge. *See Abstr.* 690

538.566.2 : 621.396.65 : 621.396.822

982. Correspondence between the mean level of atmospherics and the degree of intelligibility of a radio link on kilometre-waves. F. CARBENAY. *C.R. Acad. Sci.* [*Paris*] **235**, 423–5 (*Aug.* 11); 653 (*Sept.* 29, 1952) *In French.*

Notes giving results of comparison at different times of the day between recorded mean level of atmospherics and the proportion of faulty ciphers recorded over a radio link on 27 kc/s on June 26–7, 1952. The correspondence between these parameters is exhibited graphically. G. M. BROWN

538.566.3

983. On the theory of the interaction of radio waves in the ionosphere. I. M. VILENSKIĬ. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 544–61 (1952) *In Russian.*

Develops the general theory of the interaction of electromagnetic radiation with the free electrons of the ionosphere to show that not only cross modulation is possible but also "sidebands." These are waves whose frequencies are the combination frequencies of the interacting waves. Calculations of the amplitude of such waves are made for different electron concentrations and collision frequencies between the electrons and the molecules. J. M. HOUGH

538.569.2

984. On the magnetic resonance absorption in conductors. N. BLOEMBERGEN. *J. appl. Phys.*, **23**, 1383–9 (*Dec.*, 1952).

The electromagnetic losses in conductors are analysed in terms of magnetic absorption and conduction losses. The quantities observed in a magnetic resonance experiment have a different meaning depending on whether the dimensions of the sample are large or small compared to the skin depth. Explicit formulae for electric and magnetic losses are given for the case of a plane sheet and a sphere. The influence of the conductivity on the line shape and saturation effects is discussed both for nuclear and ferromagnetic resonance. A.

MAGNETIC EFFECTS 538.6

538.632

985. Hall effect. O. LINDBERG. *Proc. Inst. Radio Engrs*, **40**, 1414–19 (*Nov.*, 1952).

The Hall effect is one of the rich sources of informa-

tion about the conduction properties of semiconductors. The mobility and carrier concentration can be obtained from the Hall constant in conjunction with the resistivity; this cannot be done with the resistivity alone. The mobility is pertinent to the understanding of transistors since such things as high-frequency cut-off and the intrinsic current gain of the transistor are related to this property of Ge. The Hall effect and associated thermomagnetic and galvanomagnetic (Ettingshausen, Nernst, Righi–Leduc and Ohmic) effects are discussed. The elimination of the effect of associated phenomena from the Hall measurement can be achieved in several ways. Some of the methods which are used to-day in the study of Ge are discussed, and typical apparatus is described. A.

538.632

986. Interpretation of the electron-inertia experiment for metals with positive Hall coefficients. N. ROSTOKER. Letter in *Phys. Rev.*, **88**, 952 (*Nov.* 15, 1952).

A view, put forward by Darwin (1936), that electron-inertia experiments do not reveal the energy levels in metals, is upheld. The value of e/m as obtained by these experiments should always be nearly equal to the value for free electrons in slow motion even if the conductor has a positive Hall effect. This is discussed with reference to a letter by Brown and Barnett [Abstr. 8358 (1952)]. See also abstract following. P. T. LANDSBERG

538.632

987. Interpretation of e/m values for electrons in crystals. W. SHOCKLEY. Letter in *Phys. Rev.*, **88**, 953 (*Nov.* 15, 1952).

See preceding abstract. The same point is dealt with, and the two authors are in agreement.

P. T. LANDSBERG

538.632

988. The Hall effect in nickel ferrite. S. FONER. Letter in *Phys. Rev.*, **88**, 955 (*Nov.* 15, 1952).

Describes measurements for a slightly impure nickel ferrite specimen. The Hall potential is given by a formula similar to that valid for ferromagnetic metals [Abstr. 1955, 5622 (1951)] and characteristic parameters for the substance may be deduced from the measurements. E. P. WOHLFARTH

538.65

989. Magnetostrictive effect and the Δ-E effect in nickel. H. NÖDTVEDT. Letter in *Nature* [*London*] **170**, 884–5 (*Nov.* 22, 1952).

See Abstr. 1138 (1952). Describes experiments on a longitudinally vibrating ferromagnetic rod for which, if the frequency is an odd harmonic, coupling effects which lead to an interchange of mechanical and magnetostrictive energy are observed. This effect modifies the changes in resonant frequency caused by the ΔE effect. E. P. WOHLFARTH

538.652 : 621.318.013

990. Proposal of piezomagnetic nomenclature for magnetostrictive materials. S. L. EHRLICH. Letter in *Proc. Inst. Radio Engrs*, **40**, 992 (*Aug.*, 1952).

A system of nomenclature for piezomagnetic equations of state which would be comparable to piezoelectric terminology. This would facilitate any comparison of magnetostrictive, piezoelectric and electrostrictive materials and devices from a basic point of view. A specific field in which this system would be useful is that of underwater sound transducers.

S. C. DUNN (R)

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

991. Lattice vibrations in graphite. R. W. GURNEY. *Phys. Rev.*, **88**, 465–6 (*Nov.* 1, 1952).

In both natural and artificial graphites the crystallites are reported to be agglomerates of smaller units, each containing perhaps not more than 12 to 17 well-ordered planes. For atomic displacements perpendicular to a plane the restoring forces are much weaker than for similar displacements in the plane itself. For the latter the restoring forces are so strong that these lattice vibrations will not be excited at low temperatures. In this paper the requisite adaptation of the Debye theory of specific heat is given; it leads to a T^2-law instead of the familiar T^3-law at low temperatures. Unpublished measurements of specific heat between 25° and 60°K by Estermann and Kirkland are cited and compared with the theory; they are found to lead to a value $\theta_D = 614°$ for the Debye temperature for the vibrations with weak restoring forces. Combining this with a value $\theta_D = 2100°$ for the remaining modes of vibration is found to represent the specific heat over the whole range of temperature. A.

MOLECULAR STRUCTURE 539.13

539.13

992. London dispersion forces between unlike molecules. J. F. HORNIG AND J. O. HIRSCHFELDER. Letter in *J. chem. Phys.*, **20**, 1812 (*Nov.*, 1952).

An expression for the interaction energy is derived in terms of the resonant frequencies and polarizabilities of the two systems by an extension of Margenau's (1938) method for like molecules. This generalization emphasizes inconsistencies in the original method.

H. H. GREENWOOD

539.13

993. Intermolecular forces in acetone and methyl alcohol. V. MYERS. *J. chem. Phys.*, **20**, 1806 (*Nov.*, 1952).

The long-range intermolecular forces between acetone molecules and between methyl alcohol molecules are computed from optical dispersion data and dipole moments, and the short-range repulsive forces are estimated from second virial coefficients. The experimental second virial coefficients for $(CH_3)_2CO$ and CH_3OH are those of Lambert and his co-workers [Abstr. 1888 (1949)]. A.

539.13

994. Convergence of intermolecular force series. G. M. Roe. *Phys. Rev.*, **88**, 659 (*Nov.* 1, 1952).

The second-order perturbation energy of the hydrogen molecule ion is recalculated without resorting to the mathematical approximations used by Brooks or by Unsöld. The disagreement between the corrected perturbation calculations and the exact results of Hylleraas is presumably due to the neglect of exchange forces in the initial perturbation formula and cannot be removed by Brooks' proposed scheme of arbitrarily limiting the range of integration in the matrix elements. A.

539.13 : 541.124

995. Relations between molecular structure, vibrations and chemical reactivity. J. Duchesne. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 1–2, 197–218 (1952) *In French.*

Instead of the static molecular model generally used for the investigation of reaction phenomena, a dynamical model is proposed. The molecular vibrations are considered, and those selected which create atomic configurations favourable to addition or substitution reactions. Ethylene is taken as an example: the torsional vibration (1027 cm^{-1}) of this molecule changes the interaction of the 2 $p\pi$ orbitals: the free valences of both C atoms increase, and when the torsional angle is 90° there is no further interaction so that an activated complex can be formed and an addition occur. The height of this barrier is calculated (40 kcal); this value must be a measure for the activation energy. In substitution the σ electrons are involved: the deformation of symmetry B_{3u} (1444 cm^{-1}) changes the angle between two CH bonds. When the angle increases, the hybridization of the CH σ orbital changes as well: the proportion of S character increases, and with it the electronegativity of the C atom concerned. The vibration causes fluctuations in the charge densities of the C and H atoms and in the local dipole moments. The order of this change and its effect on the reaction are estimated on the basis of experimental data of several reactions. If this angle is increased to 180° and simultaneously the angle of torsion to 90°, the molecule is in a state to receive a substituent. As no account can be taken of the repulsion energies which still exist, the energy of this state must be lower than the actual activation energy. Similar calculations are carried out for the reaction $H + CH_4 \rightarrow CH_4 + H$. Torsional vibrations, as occur in ethylene, may cause some paramagnetism. This is responsible for the catalytic effect of some non-paramagnetic hydrocarbons on the para-ortho hydrogen transformation. In the case of acetylene, which has no torsional vibrations, calculations become more difficult.

A. J. TAYLOR

539.132

996. The role of the de Broglie wave in the study of molecular structures. R. Daudel. *Cahiers de Phys.*, *No.* 38, 17–25 (*July*, 1952) *In French.*

A brief summary of the applications to atomic and molecular problems. Wave mechanics is simple in principle and always exact if the equations are solved rigorously; but the calculations involved are prohibitive. No physical problem exists in principle, terms like resonance energy, etc., are mere mathematical conveniences. J. JACOBS

539.132

997. Comment on the role of indistinguishability of electrons in theoretical chemistry. R. Daudel. *C.R. Acad. Sci.* [*Paris*] **235**, 886–8 (*Oct.* 20, 1952) *In French.*

The choice of atomic or molecular orbitals is arbitrary as long as the wave function is expanded in terms which form a complete basis in Hilbert space. The language of theoretical chemistry might often be improved by reference to "wave function" rather than to "electron." J. JACOBS

539.132

998. Calculation of the ground-state energy and of the ionization potential of certain ions, free radicals, and molecules, by the method of configuration interaction. Evaluation of the heats of activation of certain reactions which these same quantities give. O. Chalvet and R. Daudel. *C.R. Acad. Sci.* [*Paris*], **235**, 960–1 (*Oct.* 27, 1952) *In French.*

The ionization energies of C_2H_4, C_3H_5, C_4H_6, together with the energies of the corresponding ions, yield the energies ΔE_π, the contribution of π-electrons to the activation energy. Results obtained by the LCAO method are confirmed by the configuration interaction method. J. JACOBS

539.132

999. The dissociation of cyclopropane under electron impact. F. H. Field. *J. chem. Phys.*, **20**, 1734–9 (*Nov.*, 1952).

The electron-impact-induced dissociations of cyclopropane are determined from the appearance potentials of the several ions formed. In general, the dissociations involve a considerable amount of atomic rearrangement, and the evidence points to the opening of the carbon ring in the formation of the C_3 ions. The energy required to convert cyclopropane to ethylene and methylene is found to 77 kcal/mole, from which it is estimated that the C–C bond dissociation energy in cyclopropane is at least 50 kcal/mole. The unexpectedly good agreement of the values of the heat of formation of an ion formed by electron impact from several different sources is noted, and a question is raised as to the role of activation energies in the electron-impact dissociations of polyatomic molecules. A.

539.132

1000. Dissociation energies of C–Br bonds in the bromo-naphthalenes, 9-bromo-phenanthrene, and 9-bromo-anthracene. M. Ladacki and M. Szwarc. Letter in *J. chem. Phys.*, **20**, 1814–16 (*Nov.*, 1952).

The pyrolysis of these compounds is investigated. Initially they split into a bromine atom and a radical. This reaction is of the first order. The logs of the rate constants of the various reactions are plotted against the reciprocal of temperature. Activation energies and frequency factors were calculated. As the recombination reaction probably requires no activation energy, the activation energy of the decomposition can be considered equal to the dissociation energy. From the values found it is concluded that the increase in size of the π electron system has little

effect on the dissociation energy, and that the interactions between σ and π electrons in the radicals are small. The decrease in C–Br dissociation energies seems due to "ortho" effects. A. J. TAYLOR

539.132

1001. Remarks on the totally symmetrical vibrational modes of pure and substituted ethylene, mainly of molecules of the type $R_2C_2R_2$. C. MANNEBACK AND J. LECOMTE. Letter in *J. Phys. Radium*, **13**, 428 (*July–Aug.–Sept.*, 1952) *In French.*

Ethylene and its substitution products of the same symmetry have three totally symmetrical vibrational modes: ν_1, valence vibration; ν_3, deformation vibration; and ν_2, the vibration of both CH_2 groups with respect to each other. They are forbidden in infrared, but can be observed in polarized Raman spectra. These frequencies are tabulated for ethylene, tetradeuteroethylene and tetrachloroethylene. The substitution decreases these frequencies considerably, especially ν_2. By taking 1623 cm^{-1} (ν_2) of ethylene and 1571 cm^{-1} (ν_1) of tetrachloroethylene as characteristic for a double C=C bond, one actually considers different kinds of vibrations. The gradual change of the frequencies for different kinds of substitution is shown, also for those cases, where substitution changes the symmetry. A. J. TAYLOR

539.132

1002. A note on rotational line strengths in slightly asymmetric rotors. D. R. LIDE, JR. *J. chem. Phys.*, **20**, 1761–3 (*Nov.*, 1952).

Direction-cosine matrix elements for slightly asymmetric rotors are calculated by a second-order perturbation treatment around the limiting symmetric rotor. This permits evaluation of the line strengths which are involved in calculations of absorption intensities, Stark effects, and nuclear-quadrupole couplings in rotational spectra. Explicit formulae are derived for the first-order terms. A.

539.132

1003. A note on the classification of normal vibrations of molecules. Y. MORINO AND K. KUCHITSU. Letter in *J. chem. Phys.*, **20**, 1809–10 (*Nov.*, 1952).

A systematic classification is proposed. Using the transformation $R = LX$ the energy of the normal mode X_k is $V = \frac{1}{2}\sum_{i,j} F_{ij}R_iR_j = \frac{1}{2}X_k^2 \sum_{i,j} L_{ik}L_{jk}F_{ij}$. If the largest term is $L_ik^2Fi^2$ this frequency is to be called characteristic for R_i. J. JACOBS

539.132

1004. Vibrational frequencies of phosphine-*d* and phosphine-d_2. R. E. WESTON, JR AND M. H. SIRVETZ. Letter in *J. chem. Phys.*, **20**, 1820–1 (*Nov.*, 1952).

Calculation of the frequencies and comparison with i.r. spectra. D. H. WHIFFEN

539.132

1005. Calculation of the limiting eigenfrequencies of the spectrum of the molecular crystals of para-dibromo-benzene, para-bromochloro-benzene and para-dichloro-benzene. N. N. PORFIREVA. *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 590–9 (1952) *In Russian.*

The analytical form of the limiting eigenfrequencies of the oscillations of 3 isomorphic crystals belonging to the space group C_{2h}^5 was determined. The selection rules for the Raman spectra were found. An estimate was made of the elastic bond coefficients. The breadth of the optical branches belonging to the orientated oscillations was also considered. The normal oscillations of the molecules of the elementary cell are characterized by 12 frequencies belonging to the 4 types of oscillations. All the oscillations are non-degenerate, since the dimensions of the 4 irreducible representations are unitary. All the molecules belonging to a simple lattice are assumed to vibrate in phase. The expression of the potential energy found therefore represents vibrations to which waves of infinite wavelength correspond. The respective frequencies are the limiting ones, i.e. their wave vector $\tau = 0$. For these frequencies the terms involving mixed products of co-ordinates and angles vanish, their coefficients tending to zero. Comparison of the expressions of kinetic energy T and potential energy V yields functions of the elastic bond coefficients, masses and moments of inertia; comparison of the Lagrange equation with the solution of the secular equation yields the limiting frequencies. The selection rules for the Raman spectrum are obtained by expanding the general representation of the tensor of polarizability in terms of irreducible representations according to group theory. B. F. KRAUS

539.132

1006. Vibration spectra and action coefficients of the ethane and deuteroethane molecules. S. A. ANTIPINA AND P. G. MASLOV. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 705–15 (1952) *In Russian.*

The potential energy constants were obtained independent of the system of dynamical coeffs. previously introduced. A resolution into components of the vibration frequencies is carried out, each of which is a one-parameter function only. J. JACOBS

539.132

1007. Vibration spectra of dimethylacetylene. P. G. MASLOV. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 716–28 (1952) *In Russian.*

Vibration frequencies were determined using the action-coeffs. of ethane and acetylene. The sensitivity of frequencies is given by their derivatives with respect to action and kinematic coeffs. J. JACOBS

539.132

1008. Action coefficients and vibration spectra of methylacetylene and of methylhaloidacetylenes. P. G. MASLOV. *Zh. eksper. teor. Fiz.* **22**, *No.* 6, 729–41 (1952) *In Russian.*

A detailed interpretation of their vibration spectra, whose frequencies depend on all bonds in the molecule. The action coeffs. are linearly related to equilibrium bond lengths C—X, in CH_3—C≡C–X; and the bond strengths of C≡C and C—C are in the ratio 3 : 1 in all 4 cases (X = H′, J, Br, Cl). J. JACOBS

539.132 : 535.343.3–14 : 536.71

Internal rotation barriers of ethyl alcohol. *See Abstr.* 822

539.132 : 536.75

1009. A note on the vibrational frequencies and the entropy of decarborane. W. E. KELLER AND H. L. JOHNSTON. *J. chem. Phys.*, **20**, 1749–51 (*Nov.*, 1952).

The infrared spectra of solid decaborane and of decaborane in a solution of CS_2 as well as the Raman

spectrum of the solution have been recorded. A rough selection of fundamental frequencies is made; this, together with the molecular parameters from X-ray data, is used for calculating $S^0_{298\cdot16}$ of the gas, for which a value of 83·85 e.u. is obtained. This figure compares with that derived from thermodynamic measurements, namely, 87·36 e.u. A.

539.132 : 541.57

1010. O—H stretching frequencies in very short and possibly symmetrical hydrogen bonds. R. E. RUNDLE AND M. PARASOL. Letter in *J. chem. Phys.*, **20**, 1487–8 (*Sept.*, 1952).

Stretching frequencies are observed in several compounds in which the O—H—O distances are well known. An empirical curve is formed, showing the dependence of the frequency upon the distance. It was also observed that broad bands, characteristic of strong H bonds, become sharper as the bond becomes more symmetric. Evidence from the spectrum of deuterated Ni dimethylglyoxime, and comparison with the spectrum of the isomorphous Pd complex, show that this and similar Ni and Pd compounds contain symmetric OH bonds. A. J. TAYLOR

539.132 : 551.593.9 : 535.338.4

Intensity distribution in the rotation-vibration spectrum of the OH molecule. *See Abstr.* 738

539.132

1011. An interpretation of the visible and near-infrared spectra of NpO_2^+ and PuO_2^{++} ions. D. M. GRUEN. Letter in *J. chem. Phys.*, **20**, 1818 (*Nov.*, 1952).

The spectra arise from transitions in the $5f^2$ configuration. They are calculated by multiplying the electronic terms of Th III by 1·11. The screening constant is 58. The zero level is $^3H_4$ and intermediate coupling is used. Best agreement between calculated and observed levels is obtained from spin-orbit coupling values of 950 cm^{-1} for NpO_2^+ and 1100 cm^{-1} for PuO_2^{++}. A table of the *LS* and *jj* coupling levels is given. C. TURNER

539.132

1012. The asymmetric rotor. X. The hydrogen sulfide spectrum in the 5150 cm^{-1} region. H. C. ALLEN, JR, P. C. CROSS AND M. K. WILSON. *J. chem. Phys.*, **20**, 1709–10 (*Nov.*, 1952).

For Pt IX, see Abstr. 9633 (1951). The absorption spectrum of H_2S in the region from 5000 to 5250 cm^{-1} has been measured and the rotational fine structure analysed. The structure can be accounted for as arising from two vibrational transitions yielding a type *A* band centred at 5147 cm^{-1} and a type *B* band centred at 5145 cm^{-1}. The excited state constants giving the best fit are: type *A* band, $A^* = 10{\cdot}04$, $B^* = 8{\cdot}68$, $C^* = 4{\cdot}61$ cm^{-1}; type *B* band, $A^* = 10{\cdot}08$, $B^* = 8{\cdot}68$, $C^* = 4{\cdot}59$ cm^{-1}. The frequencies and rotational band types indicate that these bands are the $(n_\sigma, n_\pi, n_\delta) = (110)$ (Type *A*) and the lower component of the resonating pair (020) (200) (Type *B*). A.

539.132

1013. Nuclear quadrupole coupling constants and molecular vibrations. J. DUCHESNE. *J. chem. Phys.*, **20**, 1804–5 (*Nov.*, 1952).

The nuclear quadrupole coupling constants may be expected to change with vibrational quantum number. The observations of various workers on some molecules are discussed, and the experimental results are interpreted in terms of theory. A.

539.132

1014. Spin echo measurements of nuclear spin coupling in molecules. E. L. HAHN AND D. E. MAXWELL. *Phys. Rev.*, **88**, 1070–84 (*Dec.* 1, 1952).

A new type of nuclear spin-spin coupling in molecules in liquids is investigated by means of the spin echo technique. A coupling interaction of the rotationally invariant form $\hbar J \mathbf{I}_1 \cdot \mathbf{I}_2$ in the nuclear induction Hamiltonian predicts the detailed shape of the spin echo envelope. Echo modulation frequencies corresponding to the coupling *J* and the chemical shift between non-equivalent protons are measured in a variety of compounds. A generalized method for calculating the spin echo is presented for large chemical shift and weak coupling among an arbitrary number of spins. The damping of the echo modulation, due to spin relaxation and molecular effects which interrupt the *J* coupling, is accounted for by a phenomenological treatment of the quantum-mechanical expectation value of nuclear magnetization. A.

539.132

1015. Anthracene studied by the molecular orbital method, configuration-interaction being taken into account. The fundamental configuration. J. SANTOS LUCAS. *C.R. Acad. Sci.* [*Paris*] **235**, 656–7 (*Sept.* 29, 1952) *In French.*

Anthracene is investigated by LCAO method: overlap integrals are taken into account. The resonance integrals are calculated for the C–C distance of 1·40 Å. Values are found for the energy levels, charge densities, free valences, and bond orders for the ground configuration. From these last the atomic distances are determined. There is good qualitative agreement with experimental values. The free valence values are in the order meso $>\alpha>\beta$. The paper will be followed by a second which takes account of configuration interaction. A. J. TAYLOR

539.133 : 535.343–14

Microwave spectra and structures of XYH_3 molecules. *See Abstr.* 742

539.133 : 541.63

1016. Rotational isomers of chloroacetyl chloride, bromoacetyl chloride, and bromoacetyl bromide. I. NAKAGAWA, I. ICHISHIMA, K. KURATANI, T. MIYAZAWA, T. SHIMANOUCHI AND S. MIZUSHIMA. *J. chem. Phys.*, **20**, 1720–4 (*Nov.*, 1952).

The Raman spectra of chloroacetyl chloride, bromoacetyl chloride and bromoacetyl bromide have been measured in the solid and liquid states. The infrared absorption spectra of these substances have also been measured in the liquid and the gaseous states. From the experimental results it has been concluded that there are two rotational isomers in the liquid and gaseous states and only one of them persists in the solid state. The temperature dependence of the intensity of the infrared absorption in the gaseous state has also been studied, and the energy difference between these two isomers has been found as $1{\cdot}0 \pm 0{\cdot}1$ kcal/mol for bromoacetyl chloride and $1{\cdot}9 \pm 0{\cdot}3$ kcal/mol for bromoacetyl bromide. The calculation

of the normal vibrations and of the product rule has been made for various configurations of rotational isomers, and it has been shown that the more stable form is the *trans* form (or nearly this one) with regard to the two halogen atoms. The less stable form is considered to have an azimuthal angle between the two carbon-halogen bonds of about 150°. A.

539.133

1017. The molecular structure of cyclobutane. J. D. DUNITZ AND V. SCHOMAKER. *J. chem. Phys.*, **20**, 1703–7 (*Nov.*, 1952).

The cyclobutane molecule has been found by electron diffraction to have the following bond distances and bond angles: C—C, $1{\cdot}56_8 \pm 0{\cdot}02$ Å; C—H, $1{\cdot}09_6 \pm 0{\cdot}04$ Å; ∠HCH, $114 \pm 8°$. On the average the ring is non-planar, with dihedral angle 20° (+10°, − 20°), but the equilibrium symmetry may be either D_{2d} (puckered ring) or D_{4h} (planar ring with low rigidity leading to large amplitude of out-of-plane bending). This point is discussed in connection with earlier spectroscopic work. The long bond distances found in four-membered rings are contrasted against the short distances in three-membered rings, and the strain energies, bond distances, and HCH angles of cycloalkanes are discussed in terms of modern valence concepts. It is suggested that the potential energy arising from a repulsion of the non-bonded carbon atoms may contribute significantly to the apparently anomalously high strain energy of cyclobutane. The repulsive force associated with such a potential is shown to account satisfactorily for the long C–C distances. A.

539.133

1018. The molecular structure of cyclopropene, C_3H_4. J. D. DUNITZ, H. G. FELDMAN AND V. SCHOMAKER. *J. chem. Phys.*, **20**, 1708–9 (*Nov.*, 1952).

Cyclopropene, C_3H_4, has been investigated by the electron diffraction method. The cyclic structure is confirmed and the following interatomic distances and angles are found: *C—C*, $1{\cdot}52_5 \pm 0{\cdot}02$ Å; *C=C*, $1{\cdot}28_6 \pm 0{\cdot}04$ Å; ⟨*C—H*⟩, $1{\cdot}08_7 \pm 0{\cdot}04$ Å; ∠H—C—H, 118° (assumed); ∠C=C—H, $152 \pm 12°$. A.

539.133

1019. On the internuclear distance and dipole moment of the LiF molecule. J. W. TRISCHKA. Letter in *J. chem. Phys.*, **20**, 1811–12 (*Nov.*, 1952).

These quantities are calculated according to a classical molecular model in which the molecule is assumed to be composed of two mutually polarized ions. Comparisons between experimental and calculated values for other alkali halides indicate the accuracy of the theoretical method. H. H. GREENWOOD

ATOMIC STRUCTURE . NUCLEUS ISOTOPES 539.15

539.152 : 537.531

1020. X-rays from mesic atoms. M. CAMAC, A. D. MCGUIRE, J. B. PLATT AND H. J. SCHULTE. Letter in *Phys. Rev.*, **88**, 134 (*Oct.* 1, 1952).

X-rays from $2p$–$1s$ transitions of pions captured by C, O and Be were detected by an NaI(Tl) crystal and 5819 photomultiplier in coincidence with scintillators in the path of the incident 40 MeV mesons. There were $0{\cdot}13 \pm 0{\cdot}03$ X-rays per pion stopped in C and $0{\cdot}21 \pm 0{\cdot}07$ for water. W. J. SWIATECKI

539.152 : 537.531

1021. X-rays from the π-mesic atom. A. M. L. MESSIAH AND R. E. MARSHAK. Letter in *Phys. Rev.*, **88**, 678 (*Nov.* 1, 1952).

It is estimated that above $Z \simeq 2$ nuclear absorption from the $2p$ state prevails over the emission of $\pi^- K_\alpha$ X-rays. A theoretical formula enables the probability of the former to be deduced from measurements on absorption from the continuum. The influence of nuclear shells is discussed. W. J. SWIATECKI

539.152.1

1022. Nuclear isomerism and shell structure. M. GOLDHABER AND R. D. HILL. *Rev. mod. Phys.*, **24**, 179–239 (*July*, 1952).

Table I summarizes all known isomers, divided into four classes (odd *Z*–even *N*; even *Z*–odd *N*; etc.). For each isomer it gives the energetically upper state, the intermediate states (if any) and the final state, denoted according to the strong spin-orbit coupling shell model. Parity is also indicated. The isomers are then discussed in detail; where possible a decay scheme is given, with data contributing to information about isomeric levels. Complete references are given. The last section deals with the systematics of isomer levels. L. PINCHERLE

539.152.1

1023. Some observations of the forecast of β-stable nuclei with even mass number. R. MOCH. *J. Phys. Radium*, **13**, 415–23 (*July–Aug.–Sept.*, 1952) *In French.*

It is shown that no semi-empirical formula that has been suggested can forecast accurately the relative stability of all isobares. L. PINCHERLE

539.152.1

1024. Medium-energy nuclear physics. K. WAY. *Nucleonics*, **10**, 46–7 (*Sept.*, 1952).

A very brief summary of papers given at the University of Pittsburg in June. Nuclear shell structure and related topics are discussed. L. R. SHEPHERD

539.152.1

1025. On the spin of some odd-odd nuclei. C. MARTY AND J. PRENTKI. *C.R. Acad. Sci.* [*Paris*] **235**, 654–5 (*Sept.* 29, 1952) *In French.*

The spin is determined theoretically for the case of one neutron and one proton outside closed shells under the assumption of a central contact interaction between them. Results are in agreement with experiment only for heavy nuclei. L. PINCHERLE

539.152.1

1026. On nuclear *A* levels (first excited states). S. ROSENBLUM AND M. VALADARES. *C.R. Acad. Sci.* [*Paris*] **235**, 711–13 (*Oct.* 6, 1952) *In French.*

Regularities are observed in the variation with *Z* and $N\ (=A-2Z)$ of the excitation energies of the first excited states of heavy even-even nuclei after α-particle emission; there is a sharp max. at Pb^{208}, for which $Z = 82$, $N = 126$. The authors suggest that 1st and 2nd excited states should be denoted *A* and *B* resp. A. O. STANESBY

539.152.1

1027. Stripping and the nuclear shell model. S. T. BUTLER. Letter in *Phys. Rev.*, **88**, 685 (*Nov.* 1, 1952).

It is shown how experiments, used as a test of the shell model, on the angular distribution from certain (d, p) and (d, n) reactions give a picture of the relative admixtures of orbital momentum for the captured particle when the core is in the ground state. They in no way measure admixtures of states in the final nucleus which are due to excitation of the core.

L. PINCHERLE

539.152.1

1028. States of light nuclei from the *jj* coupling model. D. KURATH. *Phys. Rev.*, **88**, 804–8 (*Nov.* 15, 1952).

The ordering of energy levels is presented for $1p$ shell nuclei in the *jj* coupling model. Comparison of the *jj* and *LS* model predictions with experiment are given for angular momenta and magnetic moments of the ground states as well as for the shape of the binding energy curve. No decisive favouring of either model is evident. A.

539.152.1

1029. The theory of hydrogen three. R. L. PEASE AND H. FESHBACH. *Phys. Rev.*, **88**, 945–50 (*Nov.* 15, 1952).

The binding energy of the triton has been calculated by the variational method. The forces between the particles are assumed to be charge independent and to be composed of central and tensor parts, the radial dependence of each being given by Yukawa wells. The binding energy calculation is employed to determine the range of the tensor component; the other constants are fixed by the low-energy two-body data. The effective triplet range, the percentage D state in the triton, and the Coulomb energy of He^3 are then predicted. The first two of these are in satisfactory agreement with experiment; the third is in error by 25%. The final "best" potential contains only four constants, the ranges and depths of the central and tensor potentials. The triplet and singlet central forces are equal. A.

539.152.1

1030. An analysis of the energy levels of the mirror nuclei, C^{13} and N^{13}. R. G. THOMAS. *Phys. Rev.*, **88**, 1109–25 (*Dec.* 1, 1952).

An analysis employing the recent nuclear reaction theories of Wigner and others is given of the experimental data on the low-energy interactions of s, p, d orbital neutrons and protons with C^{12} and s neutrons and protons with O^{16}. Assuming the equality of nn and pp nuclear interactions, it is possible to account for the data on the s interactions if the level spacing is considered in addition to the customary two resonance parameters: reduced width and level position; in particular, the displacement of conjugate levels can be attributed to the difference of the external wave functions for the odd particle, although with an uncertainty of about 25% which is due primarily to the lack of precise knowledge of the internal Coulomb energy of the excited states. The large magnitudes of the reduced width and level spacing indicate that two-body potential interactions exist between the odd particle and the C^{12} and O^{16} cores, and the values of the respective logarithmic derivatives indicate that these interactions are of about equal strengths. The energy dependence of the radiative capture cross-section of s neutrons and protons with C^{12} can be understood if an additional quantity, the final-state reduced width, is included in the theory to take into account the energy-dependent external contribution to the transition moment. The experimental data are only sufficient to treat the p and d interactions in the one-level approximation; a reasonable explanation can be given of the observed displacements of conjugate levels in terms of the differences of the electromagnetic properties of the odd particle such as: external wave functions, spin-orbit interactions, and variations of the internal Coulomb energy. There is some indication from the data on radiative transitions that the independent-particle model also prevails in the p states; on the other hand, the small reduced widths of these states suggest a many-body description. Derivations based on the recent theories are given of the one-channel formulae and of the general one-level formulae which include the negative-energy alternatives. The radial dependences of the resonance parameters are discussed. A.

539.152.1

1031. Nuclear space and shell structure. J. GÉHÉNIAU. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 1–2, 71–7 (1952) *In French.*

Required degeneracies in energy levels might be obtained by supposing the interior of a nucleus to be a Riemannian 3-space in which nucleons move as free particles. A hyperspherical space gives the same degeneracies as a 3-dimensional harmonic oscillator. R. A. NEWING

539.152.1

1032. On the theory of nuclear shells. C. LIESSE. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 1–2, 176–81 (1952) *In French.*

Nuclear energy levels are investigated when the interior space [see preceding abstract] is hyperellipsoidal. Levels obtained from Mayer's one-particle model [Abstr. 6006 (1950)] can be derived from the present theory. R. A. NEWING

539.152.2

1033. Evidence of nonadditivity of nucleon moments in heavy nuclei. M. ROSS. *Phys. Rev.*, **88**, 935–42 (*Nov.* 15, 1952).

An attempt to evaluate additional evidence for the non-additivity of nucleon moments and to correlate it with the evidence provided by the existence of the anomaly in the H^3, He^3 moments. Attention is first given to the deviations of the static moments of heavy nuclei from the Schmidt lines. This is shown to be an unreliable and ambiguous source of information because the moments are so sensitive to deviations from pure shell model wave functions. Furthermore, the observed differences from the Schmidt lines are opposite in sign and much larger in magnitude than would be expected on the basis of H^3 and He^3, so they could only be ascribed to a non-additivity effect if that were a many-body effect. Much more reliable information is shown to be provided by the lifetimes of certain "forbidden" magnetic dipole transitions in heavy nuclei. These are the radiative processes which seem to involve one-particle transitions with $\Delta l = 2$;

hence they are forbidden on the basis of the ordinary additive moment. Here the influence of reasonable deviations from shell model functions is quite small, so the existence of the transitions is good evidence for a non-additive contribution to the moment operator. Furthermore, the magnitude of the effect is quite compatible with what would be expected on the basis of the H^3, He^3 moment anomaly. A.

539.152.2

1034. The nuclear moments of Ta^{181}. B. M. Brown and D. H. Tomboulian. *Phys. Rev.*, **88**, 1158–62 (*Dec.* 1, 1952).

An analysis of the h.f.s. pattern of several Ta II lines has made it possible to determine the separations of the three levels of the h.f.s. multiplet associated with the $5d^36s\ ^5F_1$ state of Ta II. For this multiplet, the constants A and B appearing in the energy expression $W = W_J + \frac{1}{2}AK + BK(K+1)$ have the numerical values $A = (-0{\cdot}079 \pm 0{\cdot}001)\,\text{cm}^{-1}$ and $B = (-0{\cdot}77 \pm 0{\cdot}4)\times10^{-3}\,\text{cm}^{-1}$. Calculations are carried out in order to evaluate the magnetic and quadrupole moments of the Ta^{181} nucleus. On the basis of the above measurements the magnetic moment as calculated by the Goudsmit–Fermi–Segrè formula has the value of 1·9 nuclear magnetons. Taking into account effects due to the spatial extension of the nucleus, this result is raised to 2·1 nuclear magnetons when the correction factor of 12% as listed by Klinkenberg is applied. The result for the quadrupole moment as calculated by the Casimir formula is $+5{\cdot}9\times10^{-24}\,\text{cm}^2$. According to Sternhermer this moment should be increased by a factor of 10% in order to include the effect of an induced quadrupole moment in the closed shell electrons. With this correction the quadrupole moment has the value of $+6{\cdot}5\times10^{-24}\,\text{cm}^2$. A.

539.153

1035. Electronic structure of the heaviest elements. J. K. Dawson. *Nucleonics*, **10**, 39–45 (*Sept.*, 1952).

Recent data on the magnetic properties of compounds of thorium and heavier elements is reviewed. Susceptibility measurements indicate that in the case of ions containing one, two or three unpaired electrons the 6*d* energy levels represent the ground state, while ions containing four or more unpaired electrons behave as though the 6*f* shell is occupied. Thus it would appear that in Ac, Th, Pa and U the 6*d* shell is being filled but in Pu and beyond the 5*f* shell is preferred. Neptunium appears to occupy an intermediate position with very little separation between the 6*d* and 5*f* energy levels. L. R. SHEPHERD

539.153

1036. The configuration interaction between the odd terms in the iron group. N. Rosenzweig. *Phys. Rev.*, **88**, 580–6 (*Nov.* 1, 1952).

Using Racah's methods, the matrix components of the electrostatic interaction between the terms of the configurations $d^{n-2}sp$ and $d^{n-1}p$ are expressed as linear combinations of Slater integrals. The result consists of two parts. One part represents the interaction between the terms of the parent configurations. The second part results from the coupling of the p electron to the parent groups and contains the Slater integrals $R^2(sp, dp)$ and $R^1(sp, pd)$. The appropriate linear combinations of these integrals are formed by means of the coefficients of fractional parentage, the Racah coefficients, and a spin-dependent factor. A tabulation of coefficients sufficient for the construction of the matrix components for the entire iron group is given. A.

539.153

1037. Atomic oxygen *g*-factors. E. B. Rawson and R. Beringer. Letter in *Phys. Rev.*, **88**, 677–8 (*Nov.* 1, 1952).

The Zeeman splitting of the ground $^3P_2$ and metastable $^3P_1$ states were studied with a microwave resonance apparatus. The ground configuration *g*-factor is 161 parts in 10^6 less than the *LS*-coupling value. Paschen–Back splittings of the $^3P_1$ transitions appear to be affected by configuration interaction. L. PINCHERLE

539.153

1038. The motion of an electron in the field of a mercury atom. B. M. Yavorskiĭ. Letter in *Zh. eksper. teor. Fiz.*, **22**, *No.* 5, 636–8 (1952) *In Russian.*

The perturbation of the wave function of the impinging electron by the averaged atomic field leads to corrections of ~50% in the integral cross-section for the excitation of the 6^3P_0 level, calculated as function of electron energy. W. J. SWIATECKI

539.153.4

1039. Iterative procedures and the helium wave equation. J. H. Bartlett. *Phys. Rev.*, **88**, 525–6 (*Nov.* 1, 1952).

In an attempt to solve the helium wave equation exactly, study of a 180-point mesh shows the need for an improved difference operator to approximate the Laplacian. Such an operator has been developed, allowing one to express the value of the function at one point in terms of the values at 26 neighbouring points (in three dimensions). A.

539.155.2 : 533.15

1040. A new method for the enrichment of isotopes in the transition range between Knudsen- and Poiseuille-flow. H. D. Beckey and W. E. Groth. *Z. Naturforsch.*, **7a**, 474–80 (*July*, 1952) *In German.*

The experiments shortly described in Abstr. 3806 (1952) are given in detail. Between liquid air, and room, temperature an 18% enrichment was obtained with a 50% mixture of He–Ne and 11·2% with a 50% mixture of H_2–D_2 when the mean free path was 10 times the tube radius, the lighter component moving towards the colder end. These results are explained by generalizing the theories of Pollard and Present on self-diffusion [Abstr. 2376 (1948)] and by Present and de Bethune on the flow of binary mixtures [Abstr. 3017 (1949)] by including the effect of a temperature gradient. The forward flow due to the concentration gradient is less separative than the return flow due to the temperature gradient; thus a "negative effect" is obtained. H. LONDON

539.155.4

1041. Atomic masses from palladium through xenon. R. E. Halsted. *Phys. Rev.*, **88**, 666–72 (*Nov.* 1, 1952).

The atomic masses of 42 stable nuclides in the region from Pa through Xe have been measured with a double focusing mass spectrometer. Combined with nuclear reaction mass differences the data provide a

table of 74 mass values between mass numbers 102 and 136. A fit of the Wigner semi-empirical mass formula to these values reveals an irregularity at the magic number of 50 protons similar in nature to those previously reported from this laboratory at 20 and 28 protons. Also evident is an inability of the formula to account for the binding energy variations between isobaric nuclei. An empirical modification of the formula is observed to correct largely for this latter effect. A.

539.155.4

1042. Nuclear mass determinations from disintegration energies: oxygen to sulfur. C. W. Li. *Phys. Rev.*, **88**, 1038–42 (*Dec.* 1, 1952).

Values of the atomic masses from O^{18} to S^{33} have been derived from the Q-values of nuclear reactions with a procedure of statistical adjustment. Tables are given of the most probable Q-values and the atomic masses. In combination with a previous calculation, they give a set of consistent mass values from n^1 to S^{33}, based on nuclear disintegration energies. A.

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16 : 530.162

1043. Concerning statistical fluctuations in radioactive phenomena. E. Rodgers and S. H. Rodgers. *Amer. J. Phys.*, **20**, 471–3 (*Nov.*, 1952).

A recent paper [Abstr. 2050 (1952)] on statistical fluctuations in radioactive phenomena is discussed. It is shown how their theory may be improved. Also, some results of experiments on the same subject by the present authors are presented. A.

539.16.08

1044. A comparison of iodine-131 counting methods. H. D. Bruner and J. D. Perkinson, Jr. *Nucleonics*, **10**, 57–61 (*Oct.*, 1952).

Experiments were made to determine the efficiency and sensitivity of 9 methods of measuring I^{131} activity. The I^{131} was a N.B.S. standard diluted to 34 510 disint./min.ml. The methods included 2π and 4π G.M. γ-counters; a 4π high pressure ion chamber γ-detector; a quartz-fibre electroscope; mica end-window G.M. counters; NaI scintillation counters and a methane gas-flow windowless proportional counter. The samples were counted both in solution and as evaporated layers. L. R. SHEPHERD

539.16.08

1045. British standard of radioactive iodine (^{131}I). E. C. Bullard; H. Seligman and J. L. Putman. *Nature* [*London*] **170**, 916–17 (*Nov.* 29, 1952).

Measurements by 4π solid angle, β–γ-coincidence and liquid scintillation methods show the γ-dose rate at 1 cm to be 2·5 r/hr ± 5%. The original millicurie contains 1·13 mC on this new scale. F. T. FARMER

539.16.08

1046. Lamont natural radiocarbon measurements. II. J. L. Kulp, L. E. Tryon, W. R. Eckelman and W. A. Snell. *Science*, **116**, 409–14 (*Oct.* 17, 1952).

For Pt I, see Abstr. 2051 (1952). The maximum age of the measurements is extended to 30 000 yr. A. H. COOK

539.16.08

1047. Application of the RaD method to the determination of the "chemical" age of a uranium mineral. F. Begemann, H. v. Buttlar, F. G. Houtermans, N. Isaac and E. Piccitto. *Bull. Cent. Phys. Nucléaire Bruxelles, No.* 37, 34 *pp.* (*Aug.*, 1952) *In French.*

Gives a method for measuring the Pb/U ratio, and hence the age, of a U-containing mineral. After a discussion of other methods, the one chosen is to find the ratio of RaD (a Pb isotope) to Pb. If a counter is used, a specimen of 0·5 mg Pb will suffice; photographic emulsion techniques give results with a few micrograms. Tests are described using Shinkolobwe pitchblende. F. R. HOLT

539.16.08

1048. The measurement of natural C^{14} activities in the proportional counter. V. Faltings. Note in *Naturwissenschaften*, **39**, *No.* 16, 378–9 (1952) *In German.*

The carbon was used as C_2H_6 at 2·7 atmospheres pressure. Sensitivity was checked by using tritium in the compound and varying the pressure. Results were satisfactory and experiments with CO_2 and CH_4 continue. F. R. HOLT

539.16.08

1049. Measurement of natural radioactivity background. J. W. Healy. *Nucleonics*, **10**, 14–19 (*Oct.*, 1952).

The techniques of measuring natural radioactivity carried in the atmosphere, water and the soil are described in a general manner. The importance of such measurements in the determination of hazards resulting from the operation of plants producing radioisotopes is discussed. L. R. SHEPHERD

539.163.1

1050. Isomeric levels in Pb^{201} and Pb^{202}. N. J. Hopkins. Letter in *Phys. Rev.*, **88**, 686 (*Nov.* 1, 1952).

Gamma-activities following proton bombardment of thallium have been studied. Decay periods of 50 sec (0·67, 0·42 and 0·25 MeV γ-rays) and 5·6 sec (0·87 MeV γ-ray) were assigned to Pb^{201} and Pb^{202} respectively. The period of the known Pb^{207} activity was redetermined as 0·80 ± 0·02 sec. J. J. WILKINS

539.163.2

1051. Excited levels in Ti^{48}. M. M. Miller. *Phys. Rev.*, **88**, 516–17 (*Nov.* 1, 1952).

Excited levels of Ti^{48} have been investigated by means of the radioactive decays of V^{48} and of Sc^{48}. The intensity of a 2·29 MeV γ-transition in Ti^{48} relative to the total number of V^{48} and Sc^{48} disintegrations is found to be different for the two decays. This evidence that the 2·29 MeV transition in Ti^{48} is not a cross-over is further substantiated by delayed-coincidence measurements and lifetime considerations. A.

539.163.2

1052. Silicon-31: separation from irradiated phosphorus, half life and β-energy. A. Wennerblom, K. E. Zimen and F. Ehn. *Svensk kem. T.*, **63**, 207–10 (1951).

Si^{31}, prepared by a (n, p) reaction on P_4S_3, is separated from the P and P^{32} activity by dissolving the

P_4S_3 in CS_2. The half-life was determined using an end-window G.M. counter. The mean value was calculated to be $157 \cdot 1 \pm 0 \cdot 7$ min. The max. energy of the β-radiation was determined as 1·48 MeV by measuring the absorption of the β-rays in Al and by making a Feather analysis of the absorption curve obtained. BRITISH ABSTRACTS

539.163.2

1053. Scintillation spectrometer studies on the decay schemes of silver-110, antimony-124 and iodine-131. S. ALMQVIST AND S. A. E. JOHANSSON. Letter in *Nature* [*London*] **170,** 583–4 (*Oct.* 4, 1952).

In a double scintillation spectrometer, one spectrometer feeds a single-channel pulse-analyser which gates the brightness of a pulse-height spectrograph in the other channel, so that the corresponding coincidence spectrum is obtained directly.

A. O. STANESBY

539.163.2

1054. Energy levels associated with the radioactive decay of Gd^{153} and Tb^{161}. J. M. CORK, J. M. LEBLANC, W. H. NESTER AND F. B. STUMPF. Letter in *Phys. Rev.*, **88,** 685–6 (*Nov.* 1, 1952).

Spins and parities are allotted to the energy levels of Eu^{153}, Tb^{161} and Dy^{161} on the basis of the internal conversion ratios of the corresponding γ-rays; there is at present a discrepancy with the single-particle shell theory for the decay of Gd^{161}. A. O. STANESBY

539.163.2

1055. Radioisotopes of osmium. J. B. SWAN AND R. D. HILL. *Phys. Rev.*, **88,** 831–5 (*Nov.* 15, 1952).

Osmium activities of 15-day and 32-hour half-lives have been identified with Os^{191} and Os^{193}, respectively. A 14-hour activity, decaying by a 74·2 keV γ-transition into the 15-day activity, has been assigned to an isomeric state in Os^{191}. The decay scheme of Os^{191} has been investigated and a 7/2+ assignment has been made to the 15-day ground state and an $i_{13/2}$ assignment to the 14-hour isomeric state. The 7/2+ state is attributed to a coupling of an odd number of $i_{13/2}$ neutrons. A.

539.163.2

1056. The disintegration of I^{131}. J. R. HASKINS AND J. D. KURBATOV. *Phys. Rev.*, **88,** 884–6 (*Nov.* 15, 1952).

The results of the authors for internal conversion coefficients, K to L ratios and multipole assignments for the 284, 364, 638 and 723 keV γ-rays are reported. A review of recent decay schemes and a tabulation of internal conversion coefficients, K to L ratios, and relative intensities obtained by previous investigators are included. A level scheme is proposed which involves the forbiddenness of certain magnetic dipole transitions. A.

539.163.2

1057. Some neutron deficient strontium isotopes. S. V. CASTNER AND D. H. TEMPLETON. *Phys. Rev.*, **88,** 1126–8 (*Dec.* 1, 1952).

Bombardment of Rb with protons produced Sr^{81}, half-life 29 minutes, Sr^{82}, half-life 25 days, and Sr^{83}, half-life 38 hours. Sr^{81} and Sr^{83} are assigned on the basis of their positron decay to known Rb^{81} and Rb^{83}, respectively. The half-life of Rb^{83} has been redetermined as 83 days, and it has been shown that it decays in part to the 1·8 hour Kr^{83m}. Sr^{82} probably decays by electron capture to a short-lived isomer of Rb^{82}, which in turn decays by emission of 3·15 MeV positrons. In this case, the mass assignment is based on the energy required to produce the activity in a bombardment, because the known Rb^{82} was not observed as a decay product. A.

539.163.2

1058. On the half-life and decay scheme of Rb^{87}. I. BÄHNISCH, E. HUSTER AND W. WALCHER. Note in *Naturwissenschaften,* **39,** *No.* 16, 379–80 (1952) *In German.*

Equipment similar to that of Haxel and Houtermans [Abstr. 691 (1949)] was used, but it was found that the coincidences could be attributed to photons from the counter discharge. That is, Rb^{87} decays direct to the ground-state of Sr^{87}. The half-life is discussed. F. R. HOLT

539.163.2 : 539.164

1059. The specific alpha-activities and half-lives of U^{234}, U^{235}, and U^{236}. E. H. FLEMING, JR, A. GHIORSO AND B. B. CUNNINGHAM. *Phys. Rev.*, **88,** 642–52 (*Nov.* 1, 1952).

The material used for each determination was uranium very highly enriched in the isotope under investigation. Accurate volume aliquots of U^{235} were electrodeposited quantitatively on to platinum disks and were counted in a medium geometry chamber. Accurate weight aliquots of U^{234} and of U^{236} were pipetted on to platinum disks, evaporated to dryness in an induction furnace, and counted in a medium geometry chamber. The specific activities and half-lives found are (in disint./min.mg, and years, respectively): U^{234}, $(1 \cdot 370 \pm 0 \cdot 009) \times 10^7$ and $(2 \cdot 475 \pm 0 \cdot 016) \times 10^5$; U^{235} $(4 \cdot 74 \pm 0 \cdot 10) \times 10^3$ and $(7 \cdot 13 \pm 0 \cdot 16) \times 10^8$; U^{236}, $(1 \cdot 406 \pm 0 \cdot 011) \times 10^5$ and $(2 \cdot 391 \pm 0 \cdot 018) \times 10^7$. A.

539.163.2 : 539.172.13

1060. Mass assignment and gamma-radiations of the seven-hour molybdenum isomer. G. E. BOYD AND R. A. CHARPIE. Letter in *Phys. Rev.*, **88,** 681 (*Nov.* 1, 1952).

Molybdenum has been chemically separated and purified from niobium bombarded by 20 MeV protons; the γ-activity decayed with half-life $6 \cdot 95 \pm 0 \cdot 05$ hours, and gave photo-electric peaks at 290, 690 and 1464 keV ($\pm 3\%$) in a scintillation spectrometer, with corrected intensities 0·6 : 1 : 1. A stacked-foil excitation curve measurement showed a threshold at 4·6 MeV and maximum yield at 11·5 MeV, compared with 13·3 MeV and 19·5 MeV for $Nb^{93}(p, pn)Nb^{92}$. It is concluded that the molybdenum isomer has mass 93, having been formed in $Nb^{93}(p, n)Mo^{93}$, despite failure to detect reactions such as $Mo^{92}(n, \gamma)Mo^{93}$, $Mo^{94}(\gamma, n)Mo^{93}$, etc. T. G. PICKAVANCE

539.163.2 : 539.172.13

1061. Three new neutron deficient xenon isotopes. B. DROPESKY AND E. O. WIIG. Letter in *Phys. Rev.*, **88,** 683–4 (*Nov.* 1, 1952).

Spallation products of I with 240 MeV protons gave 3 new isotopes of Xe: Xe^{121}, $\frac{1}{2}$-life 40 ± 2 min; Xe^{122}, 20 ± 1 hr; and Xe^{123}, $1 \cdot 7 \pm 0 \cdot 2$ hr.

A. O. STANESBY

539.164

1062. Analysis of α-emission in the region of rare earths. C. MARTIN. *C.R. Acad. Sci.* [*Paris*] **235,** 878–80 (*Oct.* 20); 950–2 (*Oct.* 27, 1952) *In French.*

The α-energies of stable isotopes in this region are predicted; the absence of Sm^{146} and Gd^{150} can be understood. Access to this region by bombardments of Ba–Nd with C^{12} and O^{16} nuclei is discussed.

W. J. SWIATECKI

539.164

1063. The alpha-spectra of Pu^{239} and Pu^{240}. F. ASARO AND I. PERLMAN. *Phys. Rev.*, **88,** 828–31 (*Nov.* 15, 1952).

Utilizing a magnetic α-particle spectrograph the complex α-spectrum of Pu^{239} was found to consist of three groups; α_0 (69%), α_{13} (20%) and α_{51} (11%). The spectrum of Pu^{240} consisted of two groups, α_0 (76%) and α_{44} (24%). The nomenclature α_x refers to that α-group which leaves the product nucleus with an energy of x keV above the ground state. The α-particle energy of α_0 of Pu^{239} was measured as $5{\cdot}150 \pm 0{\cdot}002$ MeV and that of Pu^{240} as $5{\cdot}162 \pm 0{\cdot}004$ MeV. These values are correlated with the γ-rays and conversion electrons observed by other workers to form a partial decay scheme. A.

539.164.83

1064. Low energy delta rays due to alpha particles and to protons. P. DEMERS AND Z. L. WASIUTYNSKA. *C.R. Acad. Sci.* [*Paris*] **235,** 474–5 (*Aug.* 18, 1952) *In French.*

Using a fine grain laboratory-made emulsion the ratio of the number of δ-rays of energies greater than 5 keV along tracks due to α-particles and protons has been measured. For the same length of track a ratio of 4 was obtained provided that the measurements on the first 70 micron length of track were neglected. The distribution of δ-rays along two proton tracks each of range 3000 microns has been measured and compared with the theoretical distribution. These observations indicate that 5 keV δ-rays have been correctly identified. A. C. COATES

539.165

1065. The average energy of Sr^{90}–Y^{90} as a function of absorber. R. H. GOECKERMANN AND W. H. SEITZER. Letter in *J. chem. Phys.*, **20,** 1655 (*Oct.*, 1952).

The variations in average energy of the β-emission of an equilibrium mixture of Sr^{90} and Y^{90} were measured as a function of Al absorber using a magnetic lens spectrometer with foil absorbers. J. JACOBS

539.165

1066. The beta-spectrum of tritium and the mass of the neutrino. L. M. LANGER AND R. J. D. MOFFAT. *Phys. Rev.*, **88,** 689–94 (*Nov.* 15, 1952).

A direct determination of the β-spectrum of H^3 has been made in a high resolution magnetic spectrometer. The experimental data are fitted by a straight line Fermi plot from 5·5 keV to the maximum energy at $17{\cdot}95 \pm 0{\cdot}10$ keV. An upper limit of 250 V or 0·05% of the mass of the electron is obtained for the rest mass of the neutrino. New estimates are obtained for the H^3 comparative half-life, the neutron half-life, and the value of the Fermi universal constant of β-decay. A.

539.165

1067. Beta-spectra of Co^{56}, Co^{57}, and Co^{58}. L. S. CHENG, J. L. DICK AND J. D. KURBATOV. *Phys. Rev.*, **88,** 887–9 (*Nov.* 15, 1952).

For Co^{58} the 472 keV positron spectrum has been confirmed and the K conversion coefficient of the 805 keV γ-ray has been found to be $(2{\cdot}9 \pm 0{\cdot}2) \times 10^{-4}$. For Co^{57} the positron spectrum has been found to have an end-point energy of 320 ± 15 keV. Conversion electrons of 119 keV and 133 keV γ-rays and a very soft (< 18 keV) γ-ray emitted by Fe^{57} have been observed. The K/L ratios of the 119 keV and the 133 keV γ-rays have been estimated to be about 6·3 and 5·2 respectively. For Co^{56} two positron spectra have been observed, one having an end-point energy of $1{\cdot}53 \pm 0{\cdot}02$ MeV, the other having an end-point energy of 995 ± 25 keV. A.

539.165

1068. The beta-spectra of Pu^{239}, Pu^{240}, and Pu^{241}. M. S. FREEDMAN, F. WAGNER, JR AND D. W. ENGELKEMEIR. *Phys. Rev.*, **88,** 1155–8 (*Dec.* 1, 1952).

The β-spectrum of Pu^{241} measured in a double lens spectrometer on samples containing Pu^{239}, Pu^{240} and Pu^{241}, exhibits an allowed shape from $E_0 = 20{\cdot}5$ keV to 14 keV, where instrumental effects distort it. Conversion lines found beyond the endpoint combined with γ-scintillation counter measurements lead to the assignment of γs of 39, 53, 100, 124 and 384 keV associated with the α-decay of Pu^{239}, and a γ of 49·6 keV accompanying the α-decay of Pu^{240}; and the existence of 26·4 and 59 keV γs in Am^{241} α-decay is confirmed. A conversion line corresponding to a highly converted 41 keV γ in Am^{241} was found. γs of 100 and 145 keV probably associated with the α-branch in Pu^{241} were also found. The influence of the orbital electronic rearrangement energy on the β-decay is discussed. A.

539.165

1069. A scintillation spectrometer study of the decay of Tl^{204}. E. DER MATEOSIAN AND A. SMITH. *Phys. Rev.*, **88,** 1186–90 (*Dec.* 1, 1952).

By means of a special technique of scintillation spectroscopy, whereby radioactivity is introduced into a NaI(Tl) crystal, the β-spectrum of Tl^{204} is investigated and the assignment of the transition as "first forbidden" is confirmed. A reported weak intensity photon radiation of 70 keV energy is uniquely identified as being due to K-electron capture, and the branching ratio of the K capture process to the β-emission is determined to be $\sim 0{\cdot}015$. Utilizing the formulae for forbidden β-transitions developed by Marshak, the transition energy for the orbital capture is calculated to be ~ 400 keV. The inner bremsstrahlung associated with the K-capture is detected by coincidence measurements, and its end-point value is found to be in agreement with the transition energy calculated from the branching ratios. An upper limit of 0·2% is set for any possible K capture in Au^{198}. A.

539.165 : 539.166

1070. Angular β-particle distribution in the β-disintegration of heavy nuclei. A. Z. DOLGINOV. *Zh. eksper. teor. Fiz.*, **22,** *No.* 6, 658–67 (1952) *In Russian.*

The investigation of the β-neutrino of correlation is interesting in connection with the choice of a definite

variant (or combination of variants) of the theory of β-disintegration and may be studied on prohibited as well as on permitted spectra; it serves for determining relative values of the matrix elements related to nuclear structure and thus for verifying various models of the nucleus, using only prohibited spectra. A further use can be made of the correlation neutrino for determining angular moments and parity character of nuclear energy levels connected with β-disintegration and also for correlating β-disintegration with the meson field of nucleons. If the meson theory of β-disintegration is accepted, the matrix elements of the β-disintegration are a linear combination of the matrix elements obtained for different variants of the Fermi interaction, the choice of this combination being unambiguously determined by spin and parity character of the mesons responsible for the β-disintegration. When theory and experiment are compared, it is found that for $Z > A^{1/3}E_0$ the influence of the Coulomb field of the nucleus on β-particle angular distribution must not be neglected.

B. F. KRAUS

539.165 : 539.166

1071. β-γ angular correlation for heavy nuclei. A. Z. DOLGINOV. *Zh. eksper. teor. Fiz.*, **22**, *No.* 6, 668–76 (1952) *In Russian.*

The angular β–γ correlation becomes the more marked, the greater the angular moment of the intermediate nucleus, the greater the variation of the angular moments in the transition and the nearer the end of the β-spectrum the angular distribution is investigated. The correlation depends strongly on the charge of the nucleus. For transitions of the first prohibition, when the angular moments of the nucleus vary to 0 or to 1, the Coulomb field weakens β–γ correlation and considerably changes its character. A strong dependence of correlation on charge is also found for β-transitions of higher prohibitions. The formulae of Born's approximation may be applied on the condition $Z < A^{1/3}E_0$. If in the first prohibition transitions the angular moment changes by 2 units, the angular correlation becomes nearly independent of Z. Author obtains expressions valid for any Z and any multipole character of the subsequent γ-quantum for the first prohibition-transitions. The case of 2^l-pole magnetic and 2^{l+1}-pole electric radiation is considered. B. F. KRAUS

539.165 : 539.166

1072. Measurement of the β- and γ-radiation of radioactive materials in Röntgen units. G. BREITLING AND R. GLOCKER. Note in *Naturwissenchaften*, **39**, *No.* 17, 400 (1952) *In German.*

An Au^{198} source was placed a short distance from a phosphor, observed with a photomultiplier, in a container which could contain air or water. The $(\beta + \gamma)/\gamma$ ratio was thus measured, giving β/γ as 7·5/1. F. R. HOLT

539.165 : 539.166

1073. Contribution of nuclear radiation to the continuous γ-spectrum accompanying β-activity. J. HOROWITZ. Letter in *J. Phys. Radium*, **13**, 429–30 (*July–Aug.–Sept.*, 1952) *In French.*

It is pointed out that, if the direct β-transition is forbidden, alternative γ–β or β–γ cascade transitions may have appreciable intensities. Calculated curves show that this effect brings the β–γ correlations for allowed and forbidden ($\Delta J = 2$, tensor or pseudovector coupling) transitions into close agreement.

J. J. WILKINS

536.165 : 539.166

1074. Angular and direction-polarization correlation for Co^{60}, Cs^{134}, and Sb^{124}. R. M. KLOEPPER, E. S, LENNOX AND M. L. WIEDENBECK. *Phys. Rev.*, **88**. 695–9 (*Nov.* 15, 1952).

Using the experimental techniques of Metzger and Deutsch the γ–γ angular and direction-polarization correlations have been measured for Co^{60}, Cs^{134} and Sb^{124}. The reliable results of previous investigations were confirmed for Co^{60} and served to check the instrument. The direction-polarization of Cs^{134} is consistent with a 4–2–0; *EQ*, *EQ* spin assignment. The absence of γ–γ angular direction-polarization correlation in Sb^{124} requires a multipole mixture for the upper transition and a 3–2–0 spin assignment to the levels involved in the γ–γ transitions with no parity changes. The β–γ angular and direction-polarization correlation in Sb^{124} agrees with the 3–2–0 spin assignments for the levels of the β–γ transitions and with an *EQ* gamma. A.

539.165 : 539.166

1075. Radioactivity of scandium 43. J. R. HASKINS, J. E. DUVAL, L. S. CHENG AND J. D. KURBATOV. *Phys. Rev.*, **88**, 876–7 (*Nov.* 15, 1952).

The positron and photoelectron spectra of radioactive Sc^{43} have been investigated. A γ-ray of $0{\cdot}375 \pm 0{\cdot}002$ MeV and positron groups of $1{\cdot}18 \pm 0{\cdot}02$ MeV and $0{\cdot}77 \pm 0{\cdot}04$ MeV are assigned to the decay of Sc^{43}. A.

539.165 : 539.166

1076. Radiations of Ce^{143}. W. H. BURGUS. *Phys. Rev.*, **88**, 1129–32 (*Dec.* 1, 1952).

A spectrometric investigation of the radiations of Ce^{143} has revealed that there are β-ray groups of $1{\cdot}090 \pm 0{\cdot}005$, $1{\cdot}390 \pm 0{\cdot}005$ and $0{\cdot}710 \pm 0{\cdot}010$ MeV maximum energy. In addition, there was evidence for a fourth lower energy group which could not be resolved. Electromagnetic radiations of energies $0{\cdot}0349 \pm 0{\cdot}001$, $0{\cdot}126 \pm 0{\cdot}005$, $\sim 0{\cdot}160 \pm 0{\cdot}010$, $0{\cdot}289 \pm 0{\cdot}005$, $0{\cdot}356 \pm 0{\cdot}005$, $0{\cdot}660 \pm 0{\cdot}010$ and $0{\cdot}720 \pm 0{\cdot}010$ MeV were found. A decay scheme for Ce^{143} is proposed. A.

539.165 : 771.535

1077. Intensification of the latent photographic image produced by beta-rays. K. ZUBER. Letter in *Nature* [*London*] **170**, 669 (*Oct.* 18, 1952).

The latent image produced by exposing a Kodak NT 2a plate to β-rays can be intensified by a long low-intensity post exposure to give an increase of 50–100% in the developed density. A. C. COATES

539.165.08

1078. Autoradiographic method for identifying beta-active particles in a heterogeneous mixture. P. D. LARIVIERE AND S. K. ICHIKI. *Nucleonics*, **10**, 22–5 (*Sept.*, 1952).

The autoradiographic method was used to detect and measure radioactive particles deposited by electrostatic means from mixed radioactive and inert

aerosols on to thin glass or plastic surfaces. Stripping films were employed for the autoradiographs. The experimental techniques involved in preparing and observing the samples are described. L. R. SHEPHERD

539.165.08

1079. Film measurement of beta radiation dose. E. S. JETTER AND H. BLATZ. *Nucleonics*, **10**, 43–5 (*Oct.*, 1952).

The applicability of the film method of radiation measurement to U β-particles, particularly when the latter have been subjected to absorption, has been examined experimentally. Film density for a given dosage was found to be substantially independent of energy of electrons in the range 0·5–1·4 MeV, and was not affected by absorption, in the case of the U β-particles. L. R. SHEPHERD

539.165.2

1080. On the theory of beta-radioactivity. A. M. SMITH. *Phil. Mag.*, **43**, 915–33 (*Sept.*); Erratum, 1226 (*Nov.*, 1952).

A comparison of some experimental β-spectra with theoretical predictions when the interaction is taken as a linear combination of the five usual forms has been made, and on this basis the conclusion is that the interaction can only be a mixture of the vector and tensor forms. For two disintegrations involving light nuclei the arbitrariness in the theoretical predictions has been reduced by assuming a shell structure of nuclei and evaluating the nuclear matrix elements involved. From this analysis it is concluded that the interaction responsible for β-decay is a mixture of approximately two parts of vector form to one of tensor. A.

539.166

1081. γ-Rays of radium-D. G. T. EWAN AND M. A. S. ROSS. Letter in *Nature* [*London*] **170**, 760 (*Nov.* 1, 1952).

Measurements with a curved crystal spectrometer indicated only a $46{\cdot}52 \pm 0{\cdot}02$ keV γ-ray in the region 16–62 keV. Upper limits for the relative intensities of any other γ-rays in the region are given. J. J. WILKINS

539.166

1082. Gamma-rays from Sn^{125}. C. E. MANDEVILLE, E. SHAPIRO, R. I. MENDENHALL, E. R. ZUCKER AND G. L. CONKLIN. *Phys. Rev.*, **88**, 554–5 (*Nov.* 1, 1952).

An inner β-spectrum at $\sim 0{\cdot}5$ MeV, coincident with γ-radiation, constitutes $10 \pm 2\%$ of the total β-radiation of the 10-day Sn^{125}. The γ-rays have a maximum energy of $1{\cdot}67 \pm 0{\cdot}10$ MeV. A.

539.166

1083. Reinvestigation of the radioactivity of Sb^{124}. D. R. HUTCHINSON AND M. L. WIEDENBECK. *Phys. Rev.*, **88**, 699–700 (*Nov.* 15, 1952).

The β-spectrum of Sb^{124} was studied with a thin-lens spectrometer with particular emphasis on the internal conversion of the 0·607 and 1·7 MeV γ-rays and the shape of the high energy β-spectrum. The conversion coefficients of the 0·607 MeV γ-ray were found to be $\alpha_K = 3{\cdot}63 \pm 0{\cdot}40 \times 10^{-3}$, $\alpha_L = 5{\cdot}15 \pm 1{\cdot}0 \times 10^{-4}$. Comparison of α_K with theoretical values indicated the transition to be electric quadrupole. An upper limit of 5×10^{-4} has been set on the conversion coefficient of the 1·7 MeV γ-ray. The highest energy β-component was shown to be first-forbidden. The next highest β-component may possibly be first-forbidden also. A.

539.166

1084. Precision measurements of nuclear γ-ray wavelengths of Ir^{192}, Ta^{182}, RaTh, Rn, W^{187}, Cs^{137}, Au^{198}, and annihilation radiation. D. E. MULLER, H. C. HOYT, D. J. KLEIN AND J. W. M. DUMOND. *Phys. Rev.*, **88**, 715–93 (*Nov.* 15, 1952).

The sensitivity of the curved crystal γ-ray spectrometer has been improved (1) by replacing the multicellular Geiger counter formerly used as a detector with a NaI crystal scintillation counter, and (2) by doubling the thickness of the quartz crystal which is used for diffraction of γ-rays. Certain minute nonlinearities in the spectrometer have been detected and corrected in a recent calibration. An analysis of the precision of the instrument based on this calibration and a systematic treatment of errors due to random variations in counting rate is presented. Verification of the quoted precision is achieved by comparisons of wavelengths measured in various orders and by consistency of Ritz combinations. Precision measurements of the wavelengths and energies of nuclear γ-rays and X-rays which follow the decay of Ir^{192}, Ta^{182}, RaTh, Rn, W^{187}, Cs^{137} and Au^{198}, as well as the annihilation radiation from Cu^{64}, are tabulated. A topological system is used to enumerate all possible level schemes agreeing with a given set of Ritz combinations. This method is applied to determine possible level schemes for Ir^{192} and Ta^{182}. After all corrections, the measured wavelength of the annihilation radiation from Cu^{64} agrees, within the precision of the measurements, with the present "best" value of h/m_c (for electrons) as obtained by entirely independent methods. It is concluded that to a part in 10^4 there is no evidence for any difference in mass between positive and negative electrons. A.

539.166

1085. Explicit γ–γ angular correlations. II. Polarization correlations. S. P. LLOYD. *Phys. Rev.*, **88**, 906–8 (*Nov.* 15, 1952).

For Pt I, see Abstr. 8176 (1951). The γ–γ-angular correlation function for the case where one or both of the γ-ray detectors is able to discriminate between plane polarization states of a γ-ray is given in terms of the corresponding γ–γ directional correlation. The formulae given are directly applicable to one-three type correlations in a triple cascade, and also to direction-plane polarization correlations in which the unpolarized particle is not necessarily a γ-ray, e.g. β-polarized γ. Correlations for the case where the detectors are sensitive to circular polarizations are not treated. A.

539.166

1086. Neutron capture γ-ray spectra from the elements $Z = 17$–30 and $Z = 45$–57. B. HAMERMESH AND V. HUMMEL. *Phys. Rev.*, **88**, 916–19 (*Nov.* 15, 1952).

A NaI(Tl) scintillation counter and a 5819 photomultiplier have been used in conjunction with a very accurate and flexible twenty-channel pulse-height discriminator to study thermal neutron capture γ-ray spectra. The energy range 20 keV–10 MeV was

studied for the elements of atomic numbers 17–30 and 45–57 excluding the noble gases. In the case of chlorine, four lines are found below 2·1 MeV. These probably correspond to the first four excited states of Cl^{36}. A neutron binding energy of 8·57 ± 0·03 MeV is found for Cl^{36} by combining these lines with pair spectrometer data on the high energy lines. The method yields information on only the most prominent transitions in the capture γ-decay schemes. No systematic distribution of these prominent lines is evident from the limited number of lines that can be resolved by this technique. A.

539.166

1087. Polarization correlations of the gamma-rays of Cs^{134} and of annihilation radiation. B. L. Robinson and L. Madansky. *Phys. Rev.*, **88**, 1065–9 (*Dec.* 1, 1952).

The polarization correlation of the antiparallel cascade γ-rays of Cs^{134} has been observed. The well-known cross-polarization property of the annihilation radiation has been utilized to determine the effective geometry of the polarimeters. The observed ratio of coincidences in perpendicular and parallel orientations is 0·91 ± 0·08. This ratio is not in disagreement with previous assignments of spin and parities to the excited states of the daughter nucleus, Ba^{134}. A.

539.166.7

1088. A determination of the Doppler effect for gamma-rays of 4·5 and 4·8 MeV. G. A. Jones and D. H. Wilkinson. *Phil. Mag.*, **43**, 958–63 (*Sept.*, 1952).

The Doppler effect has been observed for the γ-rays of 4·5 and 4·8 MeV emitted in cascade when α-particles of 958 keV are captured in Li^7. The γ-rays are detected in a NaI(Tl) crystal placed successively in forward and backward directions from the lithium target; the observed shift in energy between the two directions is (1·15 ± 0·12)% and the theoretical first-order Doppler shift is 1·30%. It is remarked that these observations show the possibility of investigating certain γ-ray lifetimes in the range 10^{-14} sec upwards. A.

539.166.74

1089. The absorption of high energy X-rays in various materials. H. Janzen. *Phys. Rev.*, **88**, 653–4 (*Nov.* 1, 1952).

Effective absorption cross-sections of the X-rays exciting the well-known $Cu^{63}(\gamma, n)Cu^{62}$ reaction have been measured in a number of elements. In agreement with other workers, the experimental cross-sections have been found to be lower than those predicted by theory by a fraction roughly proportional to Z^2, which amounts to about 10% for Pb. By using the results of these measurements as a standard, the effective energies, with Pb absorbers, of the X-rays exciting the $C^{12}(\gamma, n)C^{11}$, $Mo^{92}(\gamma, n)Mo^{91}$ and, $Ag^{107}(\gamma, n)Ag^{106}$ reactions have been found to be 26·0 ± 1·4, 17·0 ± 1·0 and 16·1 ± 0·9 MeV respectively, in good agreement with resonance peak energies obtained by more elaborate methods. A.

539.166.74

1090. Spectrum of the Compton radiation from solids. K. Alexopoulos and G. Brogren. Letter in *Nature* [*London*] **170**, 886 (*Nov.* 22, 1952).

Unfiltered copper radiation is scattered on (*a*) beryllium, (*b*) graphite, (*c*) diamond at incident angles of between 17° and 45° and the scattered radiation examined with a Geiger–Müller counter. For beryllium and graphite the Compton band starts near the primary line but with diamond a forbidden zone of about 7 eV is encountered. G. I. W. Llewelyn

539.166.75

1091. Absorption of 5·3-MeV, 10·3-MeV, and 17·6-MeV gamma-rays. E. S. Rosenblum, E. F. Shrader and R. M. Warner, Jr. *Phys. Rev.*, **88**, 612–17 (*Nov.* 1, 1952).

γ-Ray absorption cross-sections have been measured for Cu, Sn, Pb and U at each of the γ-ray energies, 5·3 MeV, 10·3 MeV and 17·6 MeV. Betatron radiation collimated to give "good" geometry is used for the transmission measurements. The energy sensitive detector used is a 180° homogeneous magnetic field pair spectrometer with crystal-and-photomultiplier detectors. The measured cross-sections in units of barns per atom are at 5·3 MeV, 3·244 (Cu), 7·05 (Sn), 15·07 (Pb) and 18·43 (U); at 10·3 MeV, 3·285 (Cu), 7·95 (Sn), 17·83 (Pb) and 21·73 (U); and at 17·6 MeV, 3·688 (Cu), 9·22 (Sn), 20·47 (Pb) and 25·32 (U). The statistical errors range from 0·5% to 1·5%. The pair cross-sections are inferred by subtracting the best known values of the cross-sections for the Compton, nuclear and photoelectric effects from the total cross-section. The ratio of this pair cross-section to the value calculated from the Bethe–Heitler theory is given as a function of energy. The present results give the transition of this ratio which is greater than unity for low-energy γ-rays to a value less than unity at extremely high γ-ray energies. A.

539.166.83

1092. Internal conversion of neutron capture γ-rays. C. T. Hibdon and C. O. Muehlhause. *Phys. Rev.*, **88**, 943–4 (*Nov.* 15, 1952).

Prompt internal conversion electron lines resulting from neutron capture in $_{48}Cd^{113}$, $_{62}Sm^{149}$, $_{64}Gd^{odd}$, $_{66}Dy^{164}$ and $_{80}Hg^{199}$ have been observed. Their energies were measured in a 180° focusing, constant magnetic field, film recording β-ray spectrograph. The spectrograph was placed in a neutron beam from the Argonne heavy water reactor in such a way that the source underwent bombardment during recording. In some cases *K*, *L* and *M* lines were observed. Each element except mercury exhibited two strongly converting capture γ-ray states from a single isotope. A.

539.166.83

1093. Study of conversion electrons from $^{231}_{91}Pa$. P. Falk-Vairant. *C.R. Acad. Sci.* [*Paris*] **235**, 796–9 (*Oct.* 13, 1952) *In French.*

Using a semicircular spectrometer, the energies and approximate relative intensities of 35 conversion lines were measured. Twelve γ-rays with energies ranging from 33·6 to 383 keV account for 30 of the lines, the interpretation of the remaining 5 being uncertain. J. J. Wilkins

539.166.83

1094. On an electron-electron angular correlation. J.-M. Blum. *C.R. Acad. Sci.* [*Paris*] **235**, 948–50 (*Oct.* 27, 1952) *In French.*

Ilford G5 nuclear emulsions were irradiated with

tungsten $K\alpha_2$ X-rays, and 237 pairs of photoelectrons and associated Auger electrons ejected from Ag and Br atoms were studied. The results indicate a marked angular correlation, with maximum at ~105°. The difficulties involved in finding a theoretical explanation are discussed. J. J. WILKINS

539.166.831

1095. The photoelectric absorption of γ-rays in the *L* shell of atoms. N. MARTY. *J. Phys. Radium*, **13**, 401–4 (*July–Aug.–Sept.*, 1952) *In French.*

A brief survey is given of the photoelectric absorption cross-sections normally used, both theoretical and experimental values. The ratio τ_K/τ_L of the cross-sections for photoelectric absorption in the *K* and *L* shells was measured with a 180° spectrometer for photons of energy 411 and 140 keV, for radiators of U, Pb, Au, Ag in the first case, and Au, Ag in the second. The results are compared with relativistic and non-relativistic calculations, and found to be more in accord with the former. J. HUGHES

539.166.835

1096. The quenching of *ortho*-positronium decay by a magnetic field. J. WHEATLEY AND D. HALLIDAY. Letter in *Phys. Rev.*, **88**, 424 (*Oct.* 15, 1952).

See Abstr. 267, 3846 (1952). Using scintillators, the quenching of the 3-quantum annihilation was measured as function of field strength and of the density of the SF_6 gas in which the positronium was formed from Na^{22} positrons. There was agreement with the calculations of R. Drisko and Ore and Powell [Abstr. 4971 (1949)]. W. J. SWIATECKI

539.166.84

1097. Soft radiation from Pu^{239}. H. I. ISRAEL. Letter in *Phys. Rev.*, **88**, 679 (*Nov.* 1, 1952).

Proportional counter observations indicated X-rays of $13{\cdot}6 \pm 0{\cdot}3$, $17{\cdot}4 \pm 0{\cdot}3$ and $20{\cdot}5 \pm 0{\cdot}4$ keV (*L* X-rays of uranium) having intensities of 0·012, 0·014 and 0·003 photons per α-particle respectively. J. J. WILKINS

539.169

1098. Efficiency of filter beds for treating radioactive waste. L. GEMMELL. *Nucleonics*, **10**, 40–2 (*Oct.*, 1952).

The absorption of various radio-isotopes including P^{32}, I^{131}, Sr^{90}, mixed fission products and pile canal water (containing mainly an anionic component), in a 6 ft deep sand filter bed, was measured by adding the activities in solution to the sewage passing through the bed. The percentage removal of activity was as high as 99 with Sr^{90}, and only 47 in the case of the pile canal water. Approximately 90% of the total absorbed activity was deposited in the top 3 in. of the bed, 8% in the next 9 in. and only 2% on the remaining 5 ft. Saturation studies on sample beds indicated that drops in the efficiency of removal of activity from active sewage, after a large volume had been filtered, was due to washing out of activity already absorbed. L. R. SHEPHERD

539.169 : 531.754

1099. Density measurement of concrete slabs using gamma radiation. E. E. SMITH AND A. C. WHIFFIN. *Engineer*, **194**, 278–81 (*Aug.* 29, 1952).

To study the performance of surface vibrators used to compact freshly placed concrete road slabs, a radioactive method was devised for rapidly determining the density of the concrete at various depths. The experimental slabs were 10 ft long by 4 ft wide by 18 in. deep, and, for the density measurements, vertical holes 2 in. in diameter were drilled into the slab at intervals of 1 ft along the centre line. A piece of radiocobalt, 14 mm long by 14 mm dia., of strength 130 mC, was lowered into each hole in turn, and the intensity of the γ-radiation emerging from the side walls of the slab was measured by Geiger counters held in lead collimating tubes aligned on the source. The counting time was 50 sec, and counts were made at vertical intervals of 1 in. The net count decreased exponentially from 1500 at a concrete density of 1·7 g/cm³ to 250 at a density of 2·3 g/cm³, the standard deviation of the density values being 0·02 g/cm³. Details are given in the paper of the physical basis of the method. A. C. WHIFFIN

NUCLEAR REACTIONS 539.17

539.17

1100. The angular distribution of scattering and reaction cross sections. J. M. BLATT AND L. C. BIEDENHARN. *Rev. mod. Phys.*, **24**, 258–72 (*Oct.*, 1952).

The general formula for the angular distribution in collisions between pairs of particles is simplified by performing explicitly all sums over magnetic quantum numbers. The resulting expressions involve coefficients introduced by Racah for the study of complex atomic spectra. The cross-sections are expressed as series in Legendre polynomials, each coefficient in the series being manifestly real. The general theory is then specialized for the case of nuclear reactions and scattering associated with one isolated resonance level of the compound nucleus. Formulae are derived for the various differential reaction cross-sections and for scattering with and without change of channel spin. The interference terms between resonance and potential scattering are written explicitly, both for neutral and for charged particles. A.

539.17

1101. The preparation of Li^6 targets. F. AJZENBERG. Letter in *Rev. sci. Instrum.*, **23**, 648 (*Nov.*, 1952).

The procedure described involves conversion of Li_2SO_4 to LiCl, followed by electrolytic deposition from a solution of LiCl in pyridine. The targets may be stored in dry xylene or dry benzene. J. J. WILKINS

539.17 : 530.145

Effect of charge symmetry on nuclear reactions. *See Abstr.* 612

539.17 : 778.34

1102. *T*-tracks in nuclear emulsions. M. BLAU AND E. O. SALANT. Letter in *Phys. Rev.*, **88**, 954 (*Nov.* 15, 1952).

A *T*-track appears as a black track with its last grain crossed by a straight thin track, and is presumed to be due to the break-up of the heavy track into two fast singly charged particles. 11 *T*-tracks were found in examining 2853 black tracks, whereas only 0·9 such events are expected on the basis of chance coincidences. A. C. COATES

539.17 : 778.34

1103. Measurements of grain density of tracks due to energetic particles recorded in photographic emulsions. Determination of minimum ionization. L. JAUNEAU AND F. HUG-BOUSSER. *J. Phys. Radium*, **13**, 465–72 (*Oct.*, 1952) *In French.*

The analysis of measurements of the grain density of tracks produced in a nuclear emulsion by shower particles, protons, mesons and electrons from μ-meson decay has enabled the minimum grain density to be determined. An increase above this minimum, corresponding to the Fermi plateau for very energetic particles, has been demonstrated. A. C. COATES

539.172 : 537.591.8

Nuclear reactions due to cosmic rays. *See Abstr.* 944–7

539.172.11

1104. A search for the nuclear reaction $^4He(\alpha, n)^7Be$. D. WALKER, W. T. LINK AND W. I. B. SMITH. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 861–2 (*Oct.*, 1952).

Using a beam of 39 MeV α-particles, an upper limit of 7×10^{-28} cm^2 was established for the cross-section. J. J. WILKINS

539.172.11

1105. Energy levels in Si^{28} excited by alpha-particles on Mg^{24}. S. G. KAUFMANN, E. GOLDBERG, L. J. KOESTER AND F. P. MOORING. *Phys. Rev.*, **88**, 673–6 (*Nov.* 1, 1952).

Alpha-particles produced by the Wisconsin electrostatic generator were used to bombard thin $Mg^{24}F_2$ targets evaporated on to pure graphite backings. The reaction products separated by a 90° magnetic analyser were observed at a laboratory angle of 164 ± 5°. Excitation curves for the reactions $Mg^{24}(\alpha, \alpha)Mg^{24}$ and $Mg^{24}(\alpha, p)Al^{27}$ were obtained and compared to the excitation curves of the $Al^{27}(p, p)Al^{27}$ and the $Al^{27}(p, \alpha)Mg^{24}$ reactions that had been obtained earlier. Cross-sections for the reaction $Mg^{24}(\alpha, p)Al^{27}$ were found to bear a simple qualitative relationship to those of the inverse reaction $Al^{27}(p, \alpha)Mg^{24}$, as suggested by the principle of detailed balance. These two excitation curves could be brought into good correspondence by assuming a Q-value of $-1{\cdot}613$ MeV for the reaction $Mg^{24}(\alpha, p)Al^{27}$. Some J-values have been assigned to the levels formed in the compound nucleus Si^{28}. A.

539.172.13 : 523.877

Nuclear reactions in the stars; proton–proton chain. *See Abstr.* 588

539.172.13 : 539.172.4

1106. The interactions of high energy nucleons with nuclei. II. G. BERNARDINI, E. T. BOOTH AND S. J. LINDENBAUM. *Phys. Rev.*, **88**, 1017–26 (*Dec.* 1, 1952).

Pt I [Abstr. 3862 (1952)] presented an analysis of the experimentally observed interactions of 300–400 MeV protons and neutrons with the nuclei of *G*-5 emulsion. General evidence for the nucleonic cascade mechanism of interaction was deduced from these results. Goldberger had previously calculated the interaction of high energy nucleons (~90 MeV) with heavy nuclei on the basis of an internal nucleonic cascade generated in a Fermi nucleon gas. However, the experimental test of these calculations by Hadley and York was indecisive. Calculations basically similar to the Goldberger type were performed for these interactions, employing the Monte Carlo method to treat the rather complicated cascades involved. The theoretical and experimental results are compared in detail and found to be essentially in agreement within error limits. Hence it is concluded that the nucleonic cascade mechanism can satisfactorily explain these interactions. A.

539.172.13

1107. $C^{12}(p, pn)C^{11}$ cross section from threshold to 340 MeV. R. L. AAMODT, V. PETERSON AND R. PHILLIPS. *Phys. Rev.*, **88**, 739–44 (*Nov.* 15, 1952).

The excitation function for the reaction $C^{12}(p,pn)C^{11}$ has been measured from threshold to 340 MeV using the Berkeley 40 ft linear accelerator and 184 in. cyclotron. Absolute cross-section measurements were made at various energies, using a Faraday cup and calibrated β-counter. The threshold occurs at $18{\cdot}5 \pm 0{\cdot}3$ MeV. The cross-section has a broad maximum of 100 millibarns near 45 MeV and decreases to 43 millibarns at 340 MeV. A.

539.172.13

1108. Proton induced reactions of thorium—fission yield curves. H. A. TEWES AND R. A. JAMES. *Phys. Rev.*, **88**, 860–7 (*Nov.* 15, 1952).

The fission yields of a number of nuclides produced in proton-induced fission of Th^{232} were determined at several proton energies in the range of 6·7 MeV to 21·1 MeV. At the same time, the relative cross-sections of the (p, n) and $(p, 3n)$ reactions on Th^{232} were also determined. It was found that, although the fission reaction was predominant at proton energies greater than 8 MeV, competition from the (p, xn) type of reaction was considerable over all energies investigated. The trough in the fission yield curve becomes shallower with increasing proton energy and this change was quantitatively determined over the energy range investigated. A model is proposed to explain the change in shape of the fission yield curves. An approximate determination of the excitation function for the (p, f) reaction was made; the shape of the resulting curve was at least qualitatively in agreement with the excitation function predicted from existing theory. A.

539.172.13

1109. Evidence for a new level in Be^7. D. M. THOMSON. Letter in *Phys. Rev.*, **88**, 954 (*Nov.* 15, 1952).

Experiments on the energies of neutrons from the $Li^7(p,n)Be^7$ reaction using 18·3 MeV protons indicate the existence of a new excited level in Be^7 at $4{\cdot}6 \pm 0{\cdot}2$ MeV, corresponding to the 4·62 MeV level of the mirror nucleus Li^7. A. O. STANESBY

539.172.13

1110. Angular correlations in the reaction $F^{19}(p, \alpha\gamma)O^{16}$. J. SEED AND A. P. FRENCH. *Phys. Rev.*, **88**, 1007–16 (*Dec.* 1, 1952).

The angular correlations between α-particles and γ-rays in transitions between states of Ne^{20} and the low excited states of O^{16} have been studied at the 669, 874 and 935 keV resonances for proton capture in F. The α-particle groups were separated magnetically from each other and from scattered protons.

The results lead to definite assignments of spin and parity to the nuclear states involved, and show that the first four excited levels of O^{16} are consistent with a simple α-particle model for this nucleus. Where interference between states occurs in the reaction, the phase differences are in accord with the predictions of modern dispersion theory. A.

539.172.13

1111. Electrostatic analysis of nuclear reaction energies. II. D. S. Craig, D. J. Donahue and K. W. Jones. *Phys. Rev.*, **88**, 808–11 (*Nov.* 15, 1952).

For Pt I, see Abstr. 2097 (1952). Electrostatic analysis of incident and product particle energies has been used to measure the following ground state Q-values: $O^{16}(d, \alpha)N^{14}$ ($3{\cdot}113 \pm 0{\cdot}0035$ MeV), $B^{10}(p, He^3)Be^8$ ($-0{\cdot}536 \pm 0{\cdot}003$ MeV), and $Be^{10}(p, \alpha)Be^7$ ($1{\cdot}147 \pm 0{\cdot}0025$ MeV). The energy of the lowest level in B^{10} has been determined to be $719 \pm 1{\cdot}6$ keV; that of Be^7 to be 429 ± 3 keV. Approximate cross-sections are given for the above reactions and upper limits for $O^{16}(d, \alpha)N^{14*}$ ($2{\cdot}3$ MeV level), and for $B^{10}(p, p')B^{10*}$ ($2{\cdot}1$ and $1{\cdot}7$ MeV levels). A.

539.172.13

1112. Magnetic lens spectrometer measurements of the radiations from light nuclear reactions. R. G. Thomas and T. Lauritsen. *Phys. Rev.*, **88**, 969–86 (*Dec.* 1, 1952).

The radiations from a number of light nuclear reactions are studied with a magnetic lens spectrometer. The γ-ray energies and intensities are determined from the photoelectric and Compton conversion processes; a new method for intensity measurements is developed in which "thick" Compton convertors are used. The complicating effects of Doppler shift and broadening on energy determinations are discussed. The following transition energies, obtained from thick targets at bombarding energies from one to two MeV, are reported: $C^{13}(d, n)N^{14}$: 725 ± 4 (assignment uncertain), 1638 ± 8, 2310 ± 12, 3381 ± 13, 5052 ± 25 and 5690 ± 50 keV; $C^{13}(d, p)C^{14}$: 6110 ± 30 keV; $C^{12}(d, p)C^{13}$: 3082 ± 7 keV; $N^{15}(p, \alpha)C^{12}$: 4443 ± 20 keV; $B^{10}(p, \alpha)Be^7$: $428{\cdot}5 \pm 1{\cdot}8$ keV; $Li^6(d, n)Be^7$: $428{\cdot}9 \pm 2$ keV; $Li^6(d, p)Li^7$: $477{\cdot}4 \pm 2$ keV; $O^{16}(d, p)O^{17}$: $870{\cdot}5 \pm 2$ keV. The internally formed positron distribution from the $3{\cdot}08$ MeV transition in C^{13} is found to be in agreement with the theoretical distribution for an electric dipole transition; the internally formed positron distributions from $C^{13} + d$ and $Be^9 + d$ are also observed but because of the uncertainty of the background, it is not possible to make unambiguous multipole assignments. The observed internal conversion line spectrum from the 870 keV transition of O^{17} indicates that the transition is electric quadrupole or a mixture of this and magnetic dipole. Semi-empirical formulae are given in the Appendix for the most probable and effective energy losses of fast electrons traversing light materials. A.

539.172.13

1113. The deuteron stripping reaction with aluminium. J. R. Holt and T. N. Marsham. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 763–4 (*Sept.*, 1952).

The reaction Al^{27} (8 MeV d, p)Al^{28} gives one proton group whose angular distribution is consistent with $l = 0$ for the captured n, and one which is a mixture of $l = 0$ and $l = 2$. This indicates that the final d-state in Al^{28} has a 10% admixture of s-state.

W. J. Swiatecki

539.172.13

1114. Elastic scattering of 10-MeV deuterons by H^3 and He^3. J. C. Allred, A. H. Armstrong, A. M. Hudson, R. M. Potter, E. S. Robinson, L. Rosen and E. J. Stovall, Jr. *Phys. Rev.*, **88**, 425–30 (*Nov.* 1, 1952).

The d-t and d-He^3 differential elastic scattering cross-sections have been measured for the 10-MeV deuteron bombarding energy of the external beam of the Los Alamos cyclotron. Nuclear plates detected the charged particles in the angular region 30° to 140° in the c.m. co-ordinate system. Although the cross-section as a function of angle shows marked asymmetries, indicative of scattering contributions from partial waves of high angular momentum, the two curves are identical above 45° in the c.m. system. A.

539.172.13

1115. d-d elastic scattering at 10·5 MeV. L. Rosen and J. C. Allred. *Phys. Rev.*, **88**, 431–2 (*Nov.* 1, 1952).

Deuterons from the 42 in. cyclotron were scattered by a thin deuterium gas target. Scattered particles were detected by photographic emulsions in a nuclear multiplate camera. The differential cross-section for elastic scattering was measured at 5° intervals in the centre-of-mass system, from 25° to 145°, the estimated absolute r.m.s. standard error of the measured cross-sections being $\pm 3{\cdot}1\%$. The measurements extend the angular range of previous measurements at 10·8 MeV [Abstr. 1798 (1950)] and are in very good agreement with their values when the difference in bombarding energy is taken into account. A.

539.172.13

1116. A study of the $H^3(d, n)He^4$ reaction. J. P. Conner, T. W. Bonner and J. R. Smith. *Phys. Rev.*, **88**, 468–73 (*Nov.* 1, 1952).

The nuclear reaction $H^3(d, n)He^4$ has been studied for deuteron energies from 10 keV to 1732 keV. The yield curve exhibits a maximum at a deuteron energy of 109 keV, where the total cross-section is $5{\cdot}1 \pm 0{\cdot}1 \times 10^{-24}$ cm^2. The experimental data accurately fit a single level Breit–Wigner resonance curve for deuteron energies below 500 keV. Above this energy the experimental cross-section is larger than predicted by a single level in the compound He^5 nucleus. A.

539.172.13

1117. Cross section and angular distribution of the $He^3(d, p)He^4$ nuclear reaction. T. W. Bonner, J. P. Conner and A. B. Lillie. *Phys. Rev.*, **88**, 473–6 (*Nov.* 1, 1952).

The cross-section for the reaction $He^3(d, p)He^4$ has been studied for deuteron energies from 188 keV to 1597 keV. The yield of protons at 0° to the deuteron beam exhibits a maximum at 400-keV deuteron energy. At this energy the angular distribution of the disintegration particles is spherically symmetrical and the total cross-section is $0{\cdot}69 \times 10^{-24}$ cm^2. At higher energies there is a preferential emission of protons at 0°. At 1600 keV the ratio of the number of protons at 0° to that at 90° is 1·08. The variation of total

cross-section with bombarding energy agrees with a calculated single level resonance formula from 188 keV to 600 keV. At higher energies the theoretical values give too small a cross-section. A.

539.172.13

1118. Angular correlations of the radiations from deuteron stripping reactions. L. C. BIEDENHARN, K. BOYER AND R. A. CHARPIE. *Phys. Rev.*, **88**, 517–19 (*Nov.* 1, 1952).

The general problem of the angular correlation of the radiations from excited states of nuclei produced in stripping reactions is discussed using the theory of Butler. The $(d, p\gamma)$ correlation is given explicitly. A.

539.172.13

1119. The ground-state of parity of N^{14}. D. A. BROMLEY. *Phys. Rev.*, **88**, 565–70 (*Nov.* 1, 1952).

Four MeV deuterons from the Rochester 27 in. cyclotron have been used to determine the angular distribution of the neutrons from the $C^{13}(d, n)N^{14}$ ground-state reaction for laboratory angles less than 45°. Similar measurements have been made on the $Be^9(d, n)B^{10}$ and $F^{19}(d, n)Ne^{20}$ ground-state reactions, primarily to confirm the applicability of the Butler stripping theory at this energy and with this particular experimental arrangement. Comparison of the experimental results with the predictions of the theory shows that there is a parity change in the $C^{13}(d, n)N^{14}$ and $Be^9(d, n)Ne^{20}$ reactions and no parity change in the $F^{19}(d, n)Ne^{20}$ reaction. Since the C^{14} and C^{13} ground states have been previously shown to have opposite parity, there can be no parity change in the C^{14} β-decay. A.

539.172.13

1120. Magnetic analysis of the proton groups from the $Na^{23}(d, p)Na^{24}$ reaction. A. SPERDUTO AND W. W. BUECHNER. *Phys. Rev.*, **88**, 574–9 (*Nov.* 1, 1952).

Thin targets of NaI evaporated on to Pt and thin Ni backings have been bombarded with deuterons accelerated to energies ranging from 1·5 to 2·2 MeV by the large M.I.T. air-insulated electro-static generator. Proton groups emitted at 90 degrees to the incident deuterons were analysed with a 180 degree magnetic spectrograph. Twenty of the observed proton groups are assigned to the $Na^{23}(d, p)Na^{24}$, Na^{24}* reaction and correspond with energy levels in Na^{24} up to 4·5 MeV. Several of the groups are closely spaced, and level spacings in Na^{24} as low as $17·0 \pm 3$ keV have been observed. A.

539.172.13

1121. Angular correlations in $(d, p$-$\gamma)$ reactions. L. J. GALLAHER AND W. B. CHESTON. Letter in *Phys. Rev.*, **88**, 682 (*Nov.* 1, 1952).

The correlation function has been calculated by extension of (d, p) stripping calculations. Correlations to be expected in the $A^{40}(d, p)A^{41}$*$(\gamma)A^{41}$ reaction are given for various possible spin and parity assignments. J. J. WILKINS

539.172.13

1122. Angular distributions of protons and tritons from deuteron-induced reactions on Be^9. H. W. FULBRIGHT, J. A. BRUNER, D. A. BROMLEY AND L. M. GOLDMAN. *Phys. Rev.*, **88**, 700–2 (*Nov.* 15, 1952).

The angular distributions and absolute cross-sections for the reactions $Be^9(d, p)Be^{10}$, $Be^9(d, p)Be^{10}$* (3·37 MeV) and $Be^9(d, t)Be^8$ have been determined with 3·6 MeV deuterons. Both proton distributions have shapes characteristic of $l_n = 1$ in the Butler theory. The peak cross-sections found for these reactions are $3·1 \pm 0·6$ and $4·5 \pm 0·9$ mb/steradian, respectively. The triton distribution is peaked at 0°. Its cross-section at 5° is $15·5 \pm 3$ mb/steradian. A.

539.172.13

1123. Magnetic analysis of the $Al^{27}(d, p)Al^{28}$ reaction. H. A. ENGE, W. W. BUECHNER AND A. SPERDUTO. *Phys. Rev.*, **88**, 963–8 (*Dec.* 1, 1952).

Thin aluminium targets have been bombarded with 1·8, 2·0 and 2·1 MeV deuterons. Protons emerging at 90 degrees with respect to the deuteron beam have been analysed in a magnetic spectrograph. Fifty proton groups have been assigned to the $Al^{27}(d, p)Al^{28}$ reaction, corresponding to the ground state and forty-nine excited states in Al^{28} between 0 and 6·35 MeV. Most of the levels form clusters and spacings as low as 13 keV have been observed. A.

539.172.13

1124. Cross section and angular distribution of the $D(d, p)T$ reaction. W. A. WENZEL AND W. WHALING. *Phys. Rev.*, **88**, 1149–54 (*Dec.* 1, 1952).

The $D(d, p)T$ reaction cross-section has been measured by two methods using D_2O ice targets. For E_d from 206 to 516 keV, a double-focusing magnetic spectrometer was used to obtain the momentum spectrum of the protons and tritons, from which the reaction cross-section can be determined. For E_d from 35 to 550 keV, the proton yield from a thick target was differentiated to obtain the cross-section. Both thin and thick target methods were used to measure the angular distribution over the energy range E_d from 35 to 550 keV. The angular distribution is expressed in terms of a Legendre polynomial expansion. Various sources of experimental error are considered and the probable error of the total cross-section is found to be $\pm 5\%$. A.

539.172.3

1125. Photon absorption cross sections in bismuth and tantalum. J. HALPERN, R. NATHANS AND A. K. MANN. Letter in *Phys. Rev.*, **88**, 679–80 (*Nov.* 1, 1952).

A delayed neutron detection method was used, and the excitation function for neutron yield was measured. The (γ, n) and $(\gamma, 2n)$ components were separated. Results for photon energies up to 25 MeV are given as graphs. The total integrated cross-sections are 2·8 MeV-barns for Ta and 3·0 MeV-barns for Bi.

F. R. HOLT

539.172.3

1126. Photon-induced reactions. D. C. PEASLEE. *Phys. Rev.*, **88**, 812–16 (*Nov.* 15, 1952).

A detailed derivation is given of the Breit–Wigner formula for the case where one particle is a photon. The half-width Γ_γ is found to have all the qualitative properties of a heavy particle half-width: It is proportional to the level spacing D and to $XP_l(X)$ where $X = \kappa R$ and P_l is the penetration probability for an uncharged particle. Γ_γ also depends explicitly on the details of the many-particle structure of the compound state, so that single-particle estimates of Γ_γ appear to

be of limited applicability. The formulae are applied to recent γ–n measurements on O^{16}, N^{14} and F^{19}. The breaks in the O^{16} excitation curve are due to resonances in O^{16}, except for the threshold, which presumably does not represent a resonance. At higher energies the giant γ–n electric dipole resonances are interpreted as indicating a certain "coherence" in the motion of the compound state, classically represented as countercurrent neutrons and protons. It is suggested that a flat shoulder in the excitation curves below the giant resonance may represent incoherent electric dipole excitation rather than coherent magnetic dipole and electric quadrupole excitation. The matrix elements necessary to fit the measured magnitudes are surprisingly large, which suggests that the one-particle wave functions have quite similar shapes in the ground state and in highly excited states. A.

539.172.3

1127. Nuclear photoprocesses at high energy. J. G. Brennan and R. G. Sachs. *Phys. Rev.*, **88**, 824–7 (*Nov.* 15, 1952).

In view of recent interest in the influence of pion production on the high-energy photonucleon cross-sections, an attempt is made to give a systematic discussion of the background effects, i.e. those high-energy effects which are not directly concerned with either the production of pions or relativistic corrections to the nucleon motion. An appropriate definition of each high-energy (irreducible) multipole moment is given. It is shown that the Siegert theorem does not apply, so even the electric dipole transition may be affected by (adiabatic) exchange currents. These and other high-energy effects are found to contribute about 5% to the electric dipole photodisintegration cross-section of the deuteron. Larger corrections are anticipated for heavier nuclei. It is shown that the corrections are calculated most readily by using the usual form of the multipole moment operators, rather than the formally correct irreducible operators. A.

539.172.3

1128. Deuteron photodisintegration at high energies. W. S. Gilbert and J. W. Rosengren. *Phys. Rev.*, **88**, 901–5 (*Nov.* 15, 1952).

The reaction $\gamma + d \rightarrow p + n$ was investigated using the photon bremsstrahlung spectrum from the Berkeley 322 MeV electron synchrotron. Protons were detected by a scintillation counter telescope system consisting of three liquid scintillators, each viewed by two or three photomultiplier tubes. Two types of target system were used: high pressure, low temperature deuterium gas and heavy water-with-water subtraction. Values for $(d\sigma/d\Omega)_\theta$ were determined at laboratory angles 30°–90° for E_γ (centre-of-mass) $= 140 \pm 15$ MeV and 200 ± 15 MeV, and at laboratory angles 30°–115° for E_γ (centre-of-mass) $= 250 \pm 15$ MeV. The following total cross-sections were determined: $\sigma_{\text{total}}(140) = 11{\cdot}8 \pm 4{\cdot}1 \times 10^{-29}$ cm^2; $\sigma_{\text{total}}(200) = 10{\cdot}0 \pm 3{\cdot}0$; $\sigma_{\text{total}}(250) = 15{\cdot}9 \pm 6{\cdot}4$. The uncertainties are standard deviations based on counting statistics only; there is an additional 40% absolute uncertainty. These cross-sections are far greater than the values predicted by theories which exclude the effects of meson interaction. However, a theoretical treatment which takes the specifically mesonic interaction into account does yield cross-sections of a magnitude comparable with those observed. A.

539.172.3

1129. (γ, pn) reaction in phosphorus. J. Halpern, A. K. Mann and R. Nathans. Letter in *Phys. Rev.*, **88**, 958 (*Nov.* 15, 1952).

The radioactivity $[(\gamma, n)]$ and total neutron $[(\gamma, n) + (\gamma, pn)]$ yields have been measured up to 22·5 MeV γ-ray energy. Absolute cross-section values are deduced. J. J. Wilkins

539.172.4

1130. Pile neutron absorption cross sections of lead 206 and 207. K. L. Aitken, D. J. Littler, E. E. Lockett and G. H. Palmer. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 761 (*Sept.*, 1952).

Comparison with B gave 25 ± 5 and 698 ± 25 mbarns respectively. W. J. Swiatecki

539.172.4

1131. Estimation of neutron energy for first resonance from thermal-neutron absorption cross sections. D. Bogart. *Nucleonics*, **10**, 35–9 (*Oct.*, 1952).

Published data on the thermal-neutron absorption cross-sections and first resonance energy of about 52 isotopes are examined and it is shown that there is a rough correlation between these two quantities, the latter increasing as the former decreases. It is shown that this correlation is approximately in accordance with the Breit–Wigner single level formula. The isotopes Gd^{157}, Sm^{149}, Cd^{113}, which have very low resonance energies and the light odd-odd nuclei Li^6, and B^{10}, exhibit a marked departure from the general trend. L. R. Shepherd

539.172.4

1132. Production of P^{33} with thermal neutrons. T. Westermark. *Phys. Rev.*, **88**, 573–4 (*Nov.* 1, 1952).

A soft β-activity was found in old P^{32} samples from the Harwell reactor. It was established that it definitely is due to a P isotope, probably P^{33}, thus confirming the findings by Jensen and Sheline. The amount of P^{33} and P^{32} samples from a 14-day irradiation of S has been found to $1{\cdot}4 \pm 0{\cdot}2\%$. The following data were found: half-life 25 ± 2 days, maximum β-energy 246 ± 5 keV, number of γ-rays at most 3·5% of the betas, cross-section for the presumed $S^{33}(n, p)P^{33}$ reaction 0·03 barn. From energy considerations the latter reaction was found to be exothermic, whereas the reaction leading to P^{32} is endothermic, and this was supported by getting a P activity as rich as 30% in P^{33} by means of a purer thermal neutron flux. The cross-section for the $S^{33}(n, p)P^{33}$ reaction for thermal neutrons was found to be $2{\cdot}3 \times 10^{-3}$ barn. A.

539.172.4

1133. Inelastic collision cross sections for 14-MeV neutrons. D. D. Phillips, R. W. Davis and E. R. Graves. *Phys. Rev.*, **88**, 600–2 (*Nov.* 1, 1952).

The inelastic collision cross-sections of a number of elements for 14 MeV neutrons have been measured, using threshold detectors inside spherical shells of the scattering material. Reactions in Cu, Al and P with thresholds at approximately 11·5 MeV, 2·6 MeV and 1·4 MeV were used as threshold detectors. A.

539.172.4

1134. $(n, 2n)$ reactions in C^{12}, Cu^{63}, and Mo^{92}. J. E. Brolley, Jr, J. L. Fowler and L. K. Schlacks. *Phys. Rev.*, **88**, 618–21 (*Nov.* 1, 1952).

The method of induced radioactivity was used to measure the $(n, 2n)$ cross-sections of C^{12}, Cu^{63} and Mo^{92} as a function of energy from threshold to 27 MeV. The positron activities of 20, 10 and 15·5 min, respectively, were employed. *K*-capture corrections were applied to the copper and molybdenum data. The copper and molybdenum data were compared with the statistical theory of Weisskopf and collaborators and satisfactory agreement from threshold to the onset of tertiary reactions was found. A.

539.172.4

1135. Total cross sections for 14-MeV neutrons. L. S. Goodman. Letter in *Phys. Rev.*, **88**, 677 (*Nov.* 1, 1952).

Twenty-one elements were bombarded with T(d, n)He neutrons, and recoil protons were detected by anthracene crystal and photomultiplier. W. J. SWIATECKI

539.172.4

1136. Fission-to-capture cross section ratio. J. R. Huizenga and R. B. Duffield. Letter in *Phys. Rev.*, **88**, 959 (*Nov.* 15, 1952).

A graph and table are given showing that the logarithm of this ratio for a particular nucleus is an approximately linear function of the neutron binding energy. The ratio decreases sharply with neutron binding energy decrease. J. HUGHES

539.172.4

1137. Total cross sections for 14-MeV neutrons. J. H. Coon, E. R. Graves and H. H. Barschall. *Phys. Rev.*, **88**, 562–4 (*Nov.* 1, 1952).

The total cross-sections of over 50 elements were measured in good geometry for 14 MeV neutrons. A plot of the square root of the total cross-section *v.* the one-third power of the atomic weight shows deviations from the linear relationship predicted by statistical theory. The deviations are most pronounced for the heaviest elements. A.

539.172.4

1138. The nuclear reactor as a research implement. A. H. Snell. *Amer. J. Phys.*, **20**, 527–35 (*Dec.*, 1952).

Several of the more significant physical experiments which have been performed in recent years with nuclear reactors as measuring instruments or as neutron sources are described. The examples are selected partly because of their importance and partly with diversification in mind. Short descriptions are given of the pile oscillator method of measuring neutron absorption cross-sections, the measurement of neutron capture γ-ray spectra, the study of neutron resonances by time-of-flight, neutron diffraction, neutron reflection and the radioactive decay of the neutron. A.

539.172.4

1139. Measurement of the ratio of the activation cross-section of manganese and the fission cross-section of uranium for thermal neutrons. Redetermination of the Chatillon neutron density standard. R. Barloutaud and A. Lévèque. *J. Phys. Radium*, **13**, 412–15 (*July–Aug.–Sept.*, 1952) *In French.*

Thin foils of U and Mn were placed together inside an ionization chamber and irradiated simultaneously in a pile neutron beam. The U fission fragments were counted directly in the ionization chamber during the irradiation and the saturation β-activity of the Mn was measured in a 4π counter. The mass of U was deduced from α-activity and that of Mn by chemical analysis. Appropriate corrections were made for self-absorption in all cases and the effect of epicadmium neutrons. A mean value of $3{\cdot}057 \pm 0{\cdot}055$ was obtained for the ratio σ_{Mn}/σ_u. The same experimental arrangement was also used to redetermine the density of thermal neutrons in water at a fixed distance from a 620 mC Ra–Be source. L. R. SHEPHERD

539.172.4

1140. The angular distribution of prompt neutrons, emitted in fission. J. S. Fraser. *Phys. Rev.*, **88**, 536–41 (*Nov.* 1, 1952).

The angular distribution, relative to the direction of motion of the fragments, of the prompt fast neutrons emitted in the thermal neutron fission of U^{233}, U^{235} and Pu^{239} has been measured. Collimated fission fragments were selected in energy in a gridded ionization chamber and coincident prompt neutrons in a given direction were counted by proton recoils in an electron collecting chamber filled with methane. The distributions obtained selecting only light fragments have been compared with curves computed on the basis of the evaporation of the neutrons from the moving fragments of the most probable mode. Reasonably good agreement is obtained if one postulates that in the fission of each of the three nuclides studied, the neutron emission probability is about 30% greater for the light fragment than for the heavy one. An upper limit of 4×10^{-14} sec following fission may be placed on the time emission of the neutrons. A.

539.172.4

1141. Possibility of the quaternary fission of uranium-235. E. W. Titterton. Letter in *Nature* [*London*] **170**, 794 (*Nov.* 8, 1952).

The evidence to date (derived from ~600 000 fission events in plates) suggests that such fission is highly improbable. W. J. SWIATECKI

539.172.4

1142. Fission neutron spectrum of Pu^{239}. N. Nereson. *Phys. Rev.*, **88**, 823–4 (*Nov.* 15, 1952).

The energy distribution of prompt and delayed neutrons originating from thermal fission of Pu^{239} has been measured from 0·5 to 8 MeV with nuclear plates. The spectrum obtained shows a maximum intensity in the 0·6 to 0·8 MeV region and an exponential slope $4{\cdot}3 \pm 0{\cdot}2$ MeV per decade of intensity in the energy region above 2 MeV. A.

539.172.4

1143. Experimental production of a divergent chain reaction. E. Fermi. *Amer. J. Phys.*, **20**, 536–58 (*Dec.*, 1952).

Except for minor editorial revisions this paper is the reproduction of a report written for the Metallurgical Laboratory of the University of Chicago

almost ten years ago, after the experimental production of a divergent chain reaction. The present first part of the report contains a general description of the first pile and of its operation. The details of the construction, preparation and testing of the materials and of the instrumentation are given by the members of the groups responsible for the work in appendices. The pile had approximately the shape of a flattened ellipsoid of graphite having 388 cm equatorial radius and 309 cm polar radius. The uranium was distributed through the graphite mass in lumps partly of metal and partly of oxide arranged in a cubic lattice array with about 21 cm cell side. The experimental procedure followed in approaching the critical dimensions and in the actual operation of the pile is described. The observed critical dimensions are compared with the expectation from the tests on the various components of the structure. A.

ATOM AND MOLECULE BEAMS . MESONS . NEUTRONS 539.18

539.18

1144. Observation of a μ-meson of short range. W. Riezler and A. Rudloff. Note in *Z. Naturforsch.*, **7a**, 570–1 (*Aug.*, 1952) *In German.*

Out of 9 complete μ tracks obtained at 2963 m, 1 showed a sudden loss of 0·55 MeV after 161 μ, which resulted in an abnormally short range. This might be due to the excitation of a nucleus.

W. J. SWIATECKI

539.18

1145. Observations of a τ-meson. M. Ceccarelli, N. Dallaporta, M. Merlin and A. Rostagni. Letter in *Nature* [*London*] **170**, 454–5 (*Sept.* 13, 1952).

A τ-meson track about 8000 μ long has been observed in a G5 plate 1200 μ thick exposed 4550 m above sea level. The lengths of the tracks of the three disintegration particles were 2600, 2000 and 100 μ long before leaving the emulsion. All three disintegration particles are believed to be π-mesons, and if this is so the mass of the τ-meson was $991 \pm 15 m_e$. J. H. FREMLIN

539.18

1146. Photoproduction of mesons in deuterium. M. Lax and H. Feshbach. *Phys. Rev.*, **88**, 509–15 (*Nov.* 1, 1952).

The production of positive mesons by photons incident on deuterium is calculated in terms of an effective Hamiltonian containing one term which is independent of and another which depends upon the nucleon spin. The meson spectrum at a given angle to the incident photon beam is evaluated at high photon energies by the closure approximation. At low and intermediate energies the closure approximation is not made but the neutron-neutron force in the final nucleon state is neglected. These spectra have been integrated over a bremsstrahlung spectrum. The total cross-section is found at high photon energies and near the threshold for meson production. It is found at high photon energies and near the threshold for meson production. It is found that the meson spectrum for small angles is sensitive to the relative size of the spin dependent and spin independent terms. A.

539.18

1147. π^0 production cross section for 430-MeV protons on H and Be. J. Marshall, L. Marshall, V. A. Nedzel and S. D. Warshaw. *Phys. Rev.*, **88**, 632–41 (*Nov.* 1, 1952).

The differential cross-section for the production of photons in the forward direction by the reaction (430 MeV $p + \mathrm{H} \rightarrow p + p + \pi^0$; $\pi^0 \rightarrow 2\gamma$) is measured as $0{\cdot}20 \times 10^{-27}$ cm²/sterad. The ratio of total to differential γ cross-section does not depend strongly on the symmetry of pion emission. With an average calculated ratio, the pion-production cross-section from hydrogen is found to be $0{\cdot}45 \times 10^{-27}$ cm². The differential γ-production cross-section in the forward direction on Be is measured to be $4{\cdot}35 \times 10^{-27}$ cm²/sterad. In analogy with the case of H it is assumed that the ratio of total to differential photon cross-section will not depend on symmetry of pion emission. With the ratio calculated for isotropic emission it is found that $\sigma_\pi^0 = 8{\cdot}7 \times 10^{-27}$ cm². A.

539.18

1148. The production of charged photomesons from deuterium and hydrogen. I. R. S. White, M. J. Jacobson and A. G. Schulz. *Phys. Rev.*, **88**, 836–50 (*Nov.* 15, 1952).

Hydrogen and deuterium gases have been bombarded in a gas target at a temperature of 77°K and at a pressure of about 140 atmospheres by the 318 ± 10 MeV "spread-out" bremsstrahlung photon beam of the Berkeley electron synchrotron. The charged π-mesons which were produced were collimated at angles of 45°, 90° and 135° to the beam direction. The π^+ mesons were detected with *trans*-stilbene scintillation crystals using $\pi\mu$, $\pi\beta$ and $\pi\mu\beta$ delayed coincidences and π^+ and π^- mesons were detected with Ilford C-2 200 micron nuclear emulsions. The ratios of the numbers of π^- to π^+ mesons produced in deuterium were $0{\cdot}96 \pm 0{\cdot}10$, $1{\cdot}09 \pm 0{\cdot}12$ and $1{\cdot}21 \pm 0{\cdot}17$ for the angles of 45°, 90° and 135° respectively. No variation of the ratio with meson energy, outside statistics, was observed. Absolute values for the π^+ meson energy distribution functions from hydrogen and deuterium per "equivalent quantum" have been measured at each of the above production angles. The differential and total cross-sections have been obtained by integrating over energy and angle, respectively. The experimental ratios of the deuterium to hydrogen cross-sections are in good agreement with the phenomenological theory of Chew and Lewis when the Hulthén deuteron function with $\beta = 6\alpha$ is used in the initial state, plane waves are used for the nucleons in the final state, and the bremsstrahlung cutoff is taken into account. The statistics of the data are, however, not sufficient to determine the amount of spin interaction. The excitation functions for hydrogen and deuterium and points on the angular distribution curves in the centre-of-mass system have been obtained. An upper limit of 0·08 of the charged π-meson cross-section was obtained for μ-meson production from deuterium. A.

539.18

1149. Nuclear cross section for 37-MeV positive pions in Pb. K. J. BUTTON. Letter in *Phys. Rev.*, **88**, 956 (*Nov.* 15, 1952).

Using the method of Barnes *et al.* [Abstr. 8479 (1952)] the value $1{\cdot}30 \pm 0{\cdot}07$ barns was found.

W. J. SWIATECKI

539.18

1150. The transverse momentum spectrum of the decay products of charged *V*-particles. C. M. YORK. *Phil. Mag.*, **43**, 985–90 (*Sept.*, 1952).

The momentum distributions in the centre of mass system for the charged secondary from the two reactions, $V^{\pm} \rightarrow \mu^{\pm} + \pi^0 + \nu$ and $V^{\pm} \rightarrow \mu^{\pm} + \nu + \nu$, have been calculated. The second of the above processes has been used to calculate the transverse momentum spectrum of the charged secondaries. This has been compared with the measured spectrum from charged *V*-particles and found to be consistent with it. It is not possible to distinguish between the two decay schemes by a study of the momentum distributions, but alternative methods of distinguishing between them are discussed. A.

539.18

1151. The *V*-particle and the composite pion. R. J. FINKELSTEIN. *Phys. Rev.*, **88**, 555–8 (*Nov.* 1, 1952).

It is assumed that the *V*-particle is described by a spinor wave function, and that the pion may be treated as a nucleon-antinucleon pair. The rates of the following reactions

$$\left.\begin{matrix}\pi \rightarrow \mu + \nu \\ V^0 \rightarrow \pi + P\end{matrix}\right\}, \text{ now written as } \left\{\begin{matrix}(P + \bar{N}) \rightarrow \mu + \nu \\ V^0 \rightarrow (\bar{P} + N) + P\end{matrix}\right.$$

are then compared under the assumption that both reactions are governed by the same form and strength of β-interaction. The ratio of the two lifetimes is independent of all numerical details of the pion structure. Putting in the observed lifetime of the pion, one finds for the lifetime of the V: 5×10^{-10} sec for $Q = 35$ MeV; and 2×10^{-10} sec for $Q = 75$ MeV. The two Q values have been interpreted in terms of a mass doublet. A.

539.185

1152. Methods for measuring fast neutron cross sections. H. H. BARSCHALL. *Rev. mod. Phys.*, **24**, 120–32 (*July*, 1952).

This is reviewed under the following headings: total cross-sections; elastic scattering and angular distributions; inelastic scattering; reactions producing charged particles; reactions producing uncharged particles. The accuracy which has been achieved is discussed; for those cross-sections not involving an absolute neutron flux determination, accuracies of the order of 1% have been attained, but only 10% where an absolute flux measurement is necessary. There are 52 references. J. HUGHES

539.185

1153. The scattering of slow neutrons in polycrystalline media. R. W. GURNEY. *Phys. Rev.*, **88**, 466–7 (*Nov.* 1, 1952).

When a neutron passing through a crystallite has insufficient energy to eject an atom from its site, excitation of a lattice vibration occurs instead. This paper deals mainly with neutrons having energy between 0·5 and 5·0 eV, the range where both the cross-section for elastic scattering σ_{el} and that for inelastic scattering σ_{in} vary rapidly with energy. In order to deal with inelastic collisions in which many phonons are exchanged, Finkelstein replaced the Debye model of the crystal by the Einstein model and gave expressions for $J_n(E)$, the probability that a neutron having energy E colliding with an atom of mass M loses at a collision n quanta. Computations of J_n for large and small M show in detail that in the slowing-down process by this mechanism a heavy element is much less efficient than a light element, as in the familiar case of fast neutrons. Since in this range of energy σ_{el} is inversely proportional to E, and since the observed total cross-section is independent of energy, this implies that σ_{in} is of the form $\sigma_{in} = \sigma_0(1 - A/E)$. Computed values of ΣJ_n are found to lead to this form, irrespective of the particular Einstein temperature assumed for the solid. A.

539.185

1154. Energy distribution of slow neutrons scattered from solids. B. N. BROCKHOUSE AND D. G. HURST. *Phys. Rev.*, **88**, 542–7 (*Nov.* 1, 1952).

The sharp dependence on energy of the Cd cross-section for neutrons of energies near 0·35 eV has been used to investigate the energy distribution of 0·35 eV neutrons scattered through 90° by Pb, Al, diamond and graphite. The transmission of the scattered neutrons by Cd filters was measured as a function of Cd thickness and compared with Cd transmissions calculated for an Einstein crystal model. In all cases agreement was obtained. For Pb and Al at room temperature the simpler model of a gas of free atoms gave equally good agreement, a well-known behaviour at high energies, but here applying when the temperature and neutron energy were only moderately greater than the Einstein temperature and much less than the binding energy. Theoretical formulae for the partial differential scattering cross-sections for the two models are given in convenient form. A.

539.185

1155. Diffusion of neutrons. G. JAFFÉ. *Phys. Rev.*, **88**, 603–11 (*Nov.* 1, 1952).

It is the object of the present investigation to include the thermal motion of the medium in the treatment of neutron diffusion, under the simplifying assumption that the collisions are such as between hard elastic spheres. The methods used are those previously established by the author in radiative and gas-kinetic transfer. They only have to be adapted to the present purpose. Boltzmann's original equation which is quadratic in the distribution functions is linearized by the assumption that the velocity distribution of the molecules is Maxwellian. The treatment of the resultant transport equation is different for "thermal" and for "fast" neutrons. Thermal neutrons are dealt with by the method of "moments." The distribution function is assumed to be of the form: Maxwellian factor times arbitrary function of direction, the latter written as a series of general spherical harmonics. Thereby, and by the use of a theorem due to Maxwell, the fundamental equation may be reduced to an infinite system of linear differential equations which have been previously treated. The case of arbitrary

geometry is treated to second order moments (inclusive). For the case of cylindrical symmetry a recurrence relation for the moments, to any order, is derived. The case of fast neutrons is treated by the method of iterated integrations. In order to make them straightforward the kernel of the integral equation is transformed into the standard form. This is achieved by characterizing the collisions in a way which is different from that usually applied. A simple example for the working of the method is given and the results are discussed. A.

539.185

1156. Neutron monochromator crystals—Fe_3O_4 and Ge. A. W. McReynolds. Letter in *Phys. Rev.*, **88**, 958 (*Nov.* 15, 1952).

Describes the use of single crystals of Ge and Fe_3O_4, the latter in the form of naturally occurring crystals of magnetite, as monochromators for neutron beams. By employing these crystals the useful range of wavelengths now available extends from 0·7 Å to 9 Å. J. THEWLIS

539.185

1157. Remarks on some questions of neutron optics. O. Halpern. *Phys. Rev.*, **88**, 1003–7 (*Dec.* 1, 1952).

Several derivations of the expression for the index of refraction of neutrons are discussed and difficulties recently raised are cleared up. The theory is extended to cover cases involving absorption (through capture or incoherent scattering). Formulae for the scattering due to disorder in crystals are used for the determination of scattering amplitudes of isotopes in agreement with direct experiments. It is shown how the polarization of neutrons scattered under small angles can be used to obtain information about the structure of mixed crystals. The problem of primary and secondary neutron extinction is also discussed in the light of a recent publication. A.

539.185

1158. Diffuse reflection of neutrons from a single crystal. R. D. Lowde. Letter in *Proc. Phys. Soc.* [*London*] *A*, **65**, 857–8 (*Oct.*, 1952).

Quantitative measurements are made on the thermal and magnetic diffuse scattering of monochromatic neutrons by a small (0·025 cm³) single crystal of Fe. The magnetic inelastic scattering cross-section is found to be about 10 millibarns. Wavelength changes on scattering are measured and found to agree with theory. J. THEWLIS

539.185.08 : 621.039.42

1159. Neutron detectors for reactor instrumentation. T. A. J. Jaques, H. A. Ballinger and F. Wade. *Instn Elect. Engrs Paper* 1433, 8 *pp.* (1952).

Discusses the principles involved in the detection of thermal neutrons and describes three types of detector used in the operation of natural-uranium graphite-moderated reactors, namely flux-scanning detectors, installed flux monitors and detectors used in association with automatic power-control plants. Flux-scanning detectors consist of linear assemblies of Chromel–Alumel thermocouples with alternate junctions coated with B. Installed flux monitors employ disks of B steel in place of the B beads. Ionization chambers may be used as installed flux monitors, and they are also used for the starting-up and control of nuclear reactors; designs and characteristics of the standard chambers are given. The problem of the γ-ray sensitivity of such chambers is considered, and a design of a compensated chamber is described in which the sensitivity to γ-rays is reduced by a factor of 160. It is thought that compensated chambers of this type will be much used for the measurement of power level in future nuclear reactors particularly in automatic power-control apparatus. A.

STRUCTURE OF SOLIDS 539.2

539.211

1160. Anelastic measurements of atomic mobility in substitutional solid solutions. A. S. Nowick, *Phys. Rev.*, **88**, 925–34 (*Nov.* 15, 1952).

A recently developed method for obtaining atomic mobility in solid solutions from the rate of anelastic relaxation, makes possible the measurement of mobilities at temperatures far below those at which conventional diffusion experiments can be carried out. It is shown that the anelastic effects obtained in substitutional solid solutions are due to a phenomenon of stress-induced ordering and that the relaxation rate is determined primarily by the rate of movement of the slower atomic species. This method is applied to a series of Ag–Zn solid solutions (Ag rich) and the relaxation time measured as a function of temperature and concentration. The results show a slight deviation from an Arrhenius law, but a mean heat of activation may be obtained for each alloy concentration. Values for the heat of activation as a function of Zn concentration range from 36·1 kcal/mole at 15·8 atom % Zn to 32·5 kcal/mole at 30·2 atom % Zn. The entropy of activation, in each case, is positive and in reasonable agreement with Zener's "strain theory." A correlation of the magnitude of the anelastic effects for various specimens of the same composition with the rigidity modulus of these specimens, shows that the contribution to the torsional anelasticity from grains with ⟨111⟩ direction close to the specimen axis is much larger than from grains aligned in the ⟨100⟩ direction. A.

539.211

1161. The mechanical and chemical behaviour of calcite cleavage faces. F. Puchegger. Note in *Naturwissenschaften*, **39**, *No.* 18, 428–9 (1952) *In German.*

Photomicrographs show the effect of scratching the surface with a diamond, and of subsequent etching. Only when drawn in a certain direction is the scratch free of splinters. A. R. STOKES

539.211 : 531.717.8

1162. Electrolytic polishing of mild steel. A study of surface roughness [rugosity]. G. van Dijck. *Bull. Soc. Roy. Belge Ingén. Industr.*, **1952**, 225–30 (*Oct.*) *In French.*

Modifications in the microgeometry of mild steel surfaces are determined as functions of initial roughness [rugosity] and of the duration of electrolytic polishing by the Disa–Electropol apparatus, which utilizes a mixture of perchloric acid and a lower alcohol

as electrolyte. The degree of roughness is measured by the Talysurf instrument. Both pieces of apparatus are described with illustrations, and 15 curves of results are included, which indicate clearly the efficiency of the method. 5 refs. H. H. HODGSON

539.211 : 539.89

1163. Scabbing of metals under explosive attack: multiple scabbing. J. S. RINEHART. *J. appl. Phys.*, **23**, 1229–33 (*Nov.*, 1952).

See Abstr. 5812 (1951). Further quantitative data bearing on the scabbing of metals under explosive attack are presented. In particular, the mechanics of the generation of multiple scabs is established. Experimental data have been obtained that show that multiple scabbing will occur whenever the maximum stress σ_0 in the transient wave that impinges on a free surface is more than double the critical normal fracture stress σ_c of the material. The number of scabs that will be formed will be equal to the first whole number smaller than the quotient σ_0/σ_c. The thickness of each scab is governed by the shape of the stress wave. A.

539.211 : 548.0

1164. Plastic deformation features on cleavage surfaces of metal crystals. J. HOLDEN. *Phil. Mag.*, **43**, 976–84 (*Sept.*, 1952).

Surface measurements are made upon kink bands, twin bands and bend planes produced in specimens cleaved from single crystals. The microscopic structure of kink bands is illustrated, while the method used to determine the twinning elements indicates relations in the shape of the twinned region. Polygonization structures produced by inhomogeneous deformation followed by annealing are illustrated interferometrically and related to growth features found in metal crystals. In the case of hexagonal close-packed crystals, deformed by glide, a type of deformation band structure of the active glide plane is illustrated. A.

539.211 : 548.0

1165. Complicated domain patterns on iron-silicon single crystals. C. F. YING, S. L. LEVY AND R. TRUELL. *J. appl. Phys.*, **23**, 1339–45 (*Dec.*, 1952).

Domain patterns on (100) surfaces of Fe–Si single crystals were observed between successive electrolytic or mechanical polishings. By repeatedly interrupting the electropolishings to examine the surfaces, complicated patterns were observed before simple ones were seen at the time when the surfaces were deeply polished. With fine mechanical polishing alone, results similar to those observed with interrupted electro-polishing were obtained, including the final appearance of simple patterns. These complicated patterns are interpreted as characteristic of strained surfaces. Complicated patterns appearing on heavily polished surfaces are, therefore, believed to be induced by local strains which are not completely removed, like those along deep scratches formed during the rough mechanical polishing. A.

539.213/.214

1166. The flow of glass at room temperatures. G. W. MOREY. Letter in *J. Opt. Soc. Amer.*, **42**, 856–7 (*Nov.*, 1952).

A 60 in. telescope mirror weighing 2000 lb has been standing on edge for 25 years. Tests accurate to 10^{-5} cm failed to detect any flow over that period. R. O. DAVIES

539.214

1167. Soil mechanics and plastic analysis or limit design. D. C. DRUCKER AND W. PRAGER. *Quart. appl. Math.*, **10**, 157–65 (*July*, 1952).

The implications of assuming soil to be a perfectly plastic body are discussed, but the validity of the assumption is not considered. A yield function is deduced which is a generalization of the Mohr–Coulomb hypothesis, being based on Mohr's circle at slip and Coulomb's rule for cohesive soils. It is shown that the plastic rate of cubical dilation is positive, showing that plastic deformation must be accompanied by an increase in volume. When slip occurs, one of the sliding masses does not merely slide upon the other but always moves away from it. Formulae are deduced for the rate of dissipation of mechanical energy per unit volume. The critical height of a vertical bank is computed from the formulae obtained, low critical heights being obtained when the soil is assumed to be unable to take tension. The upper and lower limits of the critical heights are very different. A. C. WHIFFIN

539.217

1168. Lattice vacancies and porosity in copper–nickel alloys. E. C. ELLWOOD. Letter in *Nature* [*London*] **170**, 580–1 (*Oct.* 4, 1952).

Vacuum cast alloys, especially with $< 80\%$ Ni, after being annealed for 7 days at 900°C and then reduced 50% by hammering at room temperature, showed a progressive growth on subsequent vacuum annealing at 700–970°C. This is associated with the development of a marked porosity in the samples, especially at grain boundaries, and is believed to be due to high vacancy concentrations. A. D. LE CLAIRE

539.217

1169. Mechanism for self-diffusion in graphite. G. J. DIENES. *J. appl. Phys.*, **23**, 1194–1200 (*Nov.*, 1952).

The mechanism for self-diffusion in single crystals of graphite has been examined theoretically. Calculations for vacancy and direct interchange mechanisms are based on atomic interactions within the graphite hexagonal layers. These interactions are obtained from the known systematic change of carbon-carbon bond strength with interatomic distance. In order to be able to calculate the energy of formation of an interstitial carbon atom, a potential function has been devised to account for interaction between the planes. This potential function consists of two terms, a Van der Waals' attraction and an exponential type repulsion. The adjustable constants have been evaluated from known physical data. The interplanar cohesive energy of graphite is calculated to be 4·36 kcal/mole. Comparison of the total activation energies for self-diffusion via vacancies, direct interchange and interstitial atoms indicates that direct interchange is the preferred mechanism. The activation energy for self-diffusion by means of direct interchange is estimated to be 90 kcal/mole. The present theoretical treatment is not applicable to diffusion along grain boundaries or pores. A.

539.217

1170. Studies of self-diffusion in graphite using C–14 tracer. M. H. FELDMAN, W. V. GOEDDEL, G. J. DIENES AND W. GOSSEN. *J. appl. Phys.*, **23**, 1200–6 (*Nov.*, 1952).

Self-diffusion in graphite was measured over the temperature range from 1835°C to 2370°C by observing the penetration of C–14 tracer initially applied to one end of a graphite rod. The experimental data were found to be in agreement with a diffusion mechanism consisting of concurrent volume and grain boundary processes. Activation energies for both processes (E_V and E_B) could not be uniquely obtained from the data, however. An independent determination of either is required in order to evaluate the other. On the basis of recent theoretical work, E_V may be taken to be 90 kcal/mole. From the present experiments and the above value of E_V, the activation for grain boundary diffusion, E_B, is calculated to be 75·4 kcal/mole. A.

539.217

1171. The effect of cyclotron bombardment on self-diffusion in silver. R. D. JOHNSON AND A. B. MARTIN. *J. appl. Phys.*, **23**, 1245–54 (*Nov.*, 1952).

Radioactive tracer techniques have been employed to measure the rate of self-diffusion in Ag in polycrystalline and single crystal solvents over a wide range of temperatures, and to investigate the effect of bombardment with 10 MeV protons on this diffusion process. A least squares fit of the data from laboratory control experiments with both single crystal and polycrystalline solvents in the temperature range 903°C to 640°C has yielded the diffusion constants $Q = 40\,800 \pm 700$ cal/mole and $D_0 = 0{\cdot}11 \pm 0{\cdot}05$ cm²/sec for the volume diffusion process. No effect of intense proton bombardment ranging from 0·5 to 5 μa/cm² has been detected on the volume self-diffusion process in Ag specimens which were simultaneously irradiated in the cyclotron target box and annealed at temperatures ranging from 852°C to 555°C. These results are, at least semiquantitatively, in accord with both the elastic collision model and the thermal spike model of radiation damage. Cyclotron techniques and apparatus are described in some detail. A.

539.217

1172. Development of porosity during diffusion in substitutional solid solutions. R. W. BALLUFFI AND B. H. ALEXANDER. *J. appl. Phys.*, **24**, 1237–44 (*Nov.*, 1952).

A metallographic study was made of the diffusion cones present in Cu–α–brass, Cu–Ni and Au–Ag diffusion couples. Usual sandwich type couples and also vapour-solid type couples in which the higher vapour pressure component was diffused either into our out of the couple through the vapour phase were investigated. Significant porosity was always generated by diffusion in the sandwich couples and also in the vapour-solid couples when the higher vapour pressure component was diffused out of solid solution. Upon inward diffusion from the vapour porosity formed in the Au–Ag couples but not in the Cu–α–brass or Cu–Ni couples. It is concluded that porosity may form in any alloy system when the components diffuse at different rates and that it may cause appreciable error in the measurement of diffusion coefficients if ignored. A.

539.217

1173. Determination of the pore size distribution in porous metal bodies. P. R. MARSHALL. Letter in *Nature* [*London*] **170**, 761 (*Nov.* 1, 1952).

This is done by measuring the variation with distance of the total amount of liquid drawn into the body by capillary attraction. The lower limit of pore size measurable may be extended by using a low surface-tension liquid or by centrifuging to increase the gravitational force opposing the capillary forces.

A. D. LE CLAIRE

539.217

1174. Solubility and diffusion coefficient of carbon in nickel: reaction rates of nickel–carbon alloys with barium oxide. J. J. LANDER, H. E. KERN AND A. L. BEACH. *J. appl. Phys.*, **23**, 1305–9 (*Dec.*, 1952).

Experimental values for the solubility of C in N in the range 700°C to 1300°C yield the equation $\ln S = 2{\cdot}480 - 4880/T$, where S is the solubility in grams of C per 100 grams of N. Values obtained for the diffusion coefficient in the same range fit the equation $\ln D = 0{\cdot}909 - 20\,200/T$, where D is in cm² per second. These results are of some interest in the problem of the activation of thermionic oxide coated cathodes, and the experimental method used to measure the diffusion coefficients is related to phenomena occurring in vacuum tubes. To extend the usefulness of the results in this direction, rates of reaction between diffused C and BaO coatings on Ni have been measured. It was found that the rates are diffusion limited over a wide range of conditions of interest. A.

539.218

1175. The settlement of a bed of clay under a concentrated load. J. MANDEL. *C.R. Acad. Sci.* [*Paris*] **235**, 1104–6 (*Nov.* 10, 1952) *In French.*

An earlier paper [Abstr. 3066 (1951)] dealt with the settlement of a layer of clay under a concentrated load applied perpendicularly to the surface of the soil above it, it being assumed that, when final equilibrium was attained, the distribution of stress accorded with that given by the Boussinesq theory. This is only true when the overlying soil has an elasticity equal to that of the clay and when the conditions of shear across the two faces of the layer of clay are unaffected by the settlement. Burmister's theory has now been used to study the case where the soil has a different elasticity from the clay layer and different boundary conditions hold at the limit. The settlement at a point after a given time is given, assuming that no radial displacement occurs on the two faces of the clay layer, and, when the thickness of the clay layer is made infinitely small, the formula agrees with the classical result of Terzaghi. All the results are given in the form of equations and no details are computed. A. C. WHIFFIN

539.234

1176. Uniform surface metallization by evaporation from one or more emission surfaces. P. PRUGNE AND P. LEGER. *J. Phys. Radium*, **13** (*Suppl. No.* 7–8–9) 129A–130A (*July–Aug.–Sept.*, 1952) *In French.*

Describes the detailed design of an evaporation coating apparatus in which the surface to be metallized is rotated over the source. A. H. W. BECK

539.234

1177. On the protection of thin films of molybdenum by a layer of vacuum-evaporated SiO. C. FELDMAN. *C.R. Acad. Sci.* [*Paris*] **235,** 706–7 (*Oct.* 6, 1952) *In French.*

It is found that for a sufficiently thick layer of SiO the increase of resistance of the Mo layer on exposure to the atmosphere is practically suppressed.

C. A. HOGARTH

539.234

1178. Unbacked thin films. G. A. SAWYER. *Rev. sci. Instrum.*, **23,** 604–6 (*Nov.*, 1952).

Thin self-supporting films of SiO have been prepared by evaporation on to zapon film backings which were afterwards removed by ion bombardment or solvents. The films are approximately 100 atoms thick (8 μg/cm^2) and will withstand a 3 mm Hg gas pressure differential over a disk of 8 mm dia., while passing several microamperes of deuterons in the energy range 30–100 keV. The root mean square scattering angle in the film at 30 keV is 6°. A.

539.26

1179. Structure of amorphous Se. H. RICHTER, W. KULCKE AND H. SPECHT. *Z. Naturforsch.*, **7a,** 511–32 (*Aug.*, 1952) *In German.*

A model of the structure is derived from the Fourier analysis of X-ray diffraction photographs. It is suggested that the Se chains exist in a form practically identical with that found in the crystal. The distance between neighbouring chains is, however, greater and the chains themselves are randomly displaced along their own axes. The transition from amorphous to crystalline Se takes place suddenly, without the occurrence of any intermediate structure, but does not occur everywhere at the same time, so that neighbouring regions of amorphous and crystalline Se can exist together. J. THEWLIS

539.26

1180. Relations between small-angle interferences of silk and the wax content. O. KRATKY, E. SCHAUENSTEIN AND A. SEKORA. Letter in *Nature* [*London*] **170,** 796–7 (*Nov.* 8, 1952).

A 45 Å equatorial period in alkali-treated silk fibroin is shown to be due to a waxy substance.

A. R. STOKES

539.266

1181. On the X-ray diffraction halos of molten metals (Pb/Sn system). M. ISHIGURO. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **8,** 83–5 (1951).

Measurements have been made of the diffraction angle $\phi/2$ over the whole concentration range at temperatures 30°C above the liquidus. $\phi/2$ increases with increasing Sn concentration, reaches a maximum at $\sim 50\%$ and then decreases. The results are discussed in terms of the structure of the molten alloys, and it is concluded that in dilute solutions of Sn in Pb a contraction of the quasi-lattice of molten Pb occurs by substitution of Sn atoms. A. D. LE CLAIRE

539.27

1182. Observations on Fe points in the field electron microscope. H.-W. SCHLEICHER. *Z. Naturforsch.*, **7a,** 471–4 (*July*, 1952) *In German.*

Describes a method for the production of sharp Fe points by electrolytic polishing. Such points give, in the field electron microscope, pictures of various types which differ from those obtained from W and Mo. Some of the results are thought to arise from the presence of an oxide layer at the point, and it is suggested that a crystal of Fe_3O_4 may exist there. Other results have not yet been satisfactorily accounted for. J. THEWLIS

539.27

1183. Methods in electron microscopy of solids. R. D. HEIDENREICH. *Rev. sci. Instrum.*, **23,** 583–94 (*Nov.*, 1952).

Methods of replicating solid surfaces for electron microscopy are reviewed and compared. Preparation of metal surfaces for electron microscopy is discussed and the advantages of employing electron diffraction techniques in evaluating prepared surfaces are pointed out. Examples of the application of replicas include steel, precipitation in alloys, such as Alnico 5, and studies of slip in aluminium. Growth spirals on the surfaces of crystals of *n*-paraffins are demonstrated. The use of thin metal sections and of emission electron microscopy in studying metallic structures is discussed, and examples are given. A.

539.27

1184. Thin glass layers as supports for electron microscopy. A. VAN ITTERBEEK, L. DE GREVE, G. F. VAN VEELEN AND C. A. F. TUYNMAN. Letter in *Nature* [*London*] **170,** 795–6 (*Nov.* 8, 1952).

539.27

1185. Electron microscopy of solid surfaces. V. E. COSSLETT. *Nature* [*London*] **170,** 861–3 (*Nov.* 22, 1952).

Summarizes the papers on reflection and scanning techniques given at a meeting of the Electron Microscopy Group of the Institute of Physics (Sept. 16–19, 1952). R. S. PEASE

539.27

1186. Dark field microscopy with defined lattice reflections. O. RANG AND H. SCHLUGE. *Optik*, **9,** *No.* 10, 463–72 (1952) *In German.*

Discusses various techniques for using the electron microscope as a dark field instrument. Of commercial instruments available today the Metropolitan-Vickers and the AEG-Zeiss are adaptable for this work. Many examples of photographs obtained from mica samples are given. A. H. W. BECK

539.27 : 535.826.3

A cantilever microtome for precision sectioning. *See Abstr.* 790

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.32

1187. Electro-mechanical Q-meter; a set-up for measuring the elastic modulus and losses of materials by ultrasonic oscillations. N. S. AGEEVA, I. P. ZHUKOV, M. A. ISAKOVICH, A. L. SOSEDOVA AND YU. M. SUKHAREVSKIĬ. *Zh. tekh. Fiz.*, **22,** *No.* 6, 1029–42 (1952) *In Russian.*

The main part of the installation is a "resonating packet," i.e. a rod of the tested material or, if the losses are large, a well resonating rod with pieces of

the tested material cemented to its ends. To the centre of the rod piezo-quartz plates are cemented, the capacitances and losses of which, together with the mechanical resistance of the rod (and thus of the tested material) are measured by an ordinary electrical Q-meter. The theory of the instrument is given and formulae and graphs elucidate the method of determining from the electrical measurements Young's modulus (for solid materials) or the shear modulus (for elastomers) and damping decrement. The elastic moduli and damping decrements of some solid materials so determined are given and also temperature and pressure relations of shear modulus and damping decrement of rubber so established.

B. F. KRAUS

539.32 : 537.226.2 : 537.228.1 : 548.0

The elastic properties of $ND_4D_2PO_4$ (deuterated ADP). *See Abstr.* 1236

539.32 : 539.431

1188. Influence of fatigue phenomena on the elastic modulus of steels. A. KOVACS AND P. LAURENT. *C.R. Acad. Sci.* [*Paris*] **235,** 1103–4 (*Nov.* 10, 1952) *In French.*

The hypothesis is put forward that the observed progressive change in the amount of flexure of a test-piece, as the number of cycles increases in a fatigue test, is due to a gradual redistribution of constraints associated with initial heterogeneity, rather than an intrinsic change of elastic modulus. It is claimed that this is supported by the absence of any similar effect when the stress cycle is longitudinal instead of flexural. In experiments in which test-pieces of heat-treated nickel-chrome constructional steel were subjected to alternating longitudinal tensions and compressions, no change in modulus could be detected.

J. G. OLDROYD

539.32 : 621.317.79

1189. Measurement of the modulus of elasticity of materials with the electronic vibrometer. U. P. ROSSETTI. *Ingegnere,* **26,** 1173–7 (*Oct.,* 1952) *In Italian.*

The relation $V = (E/\rho)^{\frac{1}{2}}$ between speed of sound V, modulus of elasticity E and density ρ of a material indicates a possible method of measuring E with electronic apparatus operating at the resonant frequency of the test sample. Experiments have shown a discrepancy between the values thus obtained and those obtained with the classical method, especially in the case of concrete. They also indicate the possibility of obtaining a sufficiently accurate relation between the two values. A brief description of the apparatus used is given. F. J. MIRANDA (R)

539.374

1190. Plastic deformation of germanium and silicon. C. J. GALLAGHER. *Phys. Rev.,* **88,** 721–2 (*Nov.* 15, 1952).

Single crystals of Ge and Si have been plastically deformed at elevated temperatures. Ge becomes ductile above 500°C, and Si requires temperature abo[illegible] 900°C. At temperatures below 600°C, Ge exhibits an induction period at constant load. Deformed Ge, originally n-type, remains n-type. The resistivity is increased by deforming, and the lifetime of photo-injected carriers is drastically reduced. A.

539.374

1191. The plasticity of silicon and germanium. F. SEITZ. *Phys. Rev.,* **88,** 722–4 (*Nov.* 15, 1952).

A qualitative analysis of Gallagher's measurements of plastic flow in Ge and Si is made. It is reasonable to suppose the slip occurs by motion in {111} planes of dislocations having a Burger's vector equal to an allowed translation in the $(1\bar{1}0)$ direction. It is suggested, following current thought, that the observed temperature-dependent incubation time for plastic flow is related to the freeing by thermal fluctuations of locking points of the Cottrell type associated with the broken bonds which occur along nearly pure screw dislocations that have a small edge component. It is proposed that foreign atoms reside at the broken bonds in normal materials. A discrepancy in the coefficient of the Boltzmann factor indicates, however, that these concepts cannot be applied in the most simple form. The analogy between Gallagher's measurement and those of Kramer and Maddin in β-brass is pointed out. A.

539.374

1192. Plasticity of materials. A. J. KENNEDY. *Nature* [*London*] **170,** 875–7 (*Nov.* 22, 1952).

A report on the conference of the British Society of Rheology held in September, 1952. The papers presented were concerned, in the main, with (*a*) instrumentation, and (*b*) interpretation of data. The problems of measurements on rubber, putty, plastics, clays, paper and gels were discussed under (*a*), with (*b*) devoted to an examination of creep phenomena in metals. It would appear that whilst instrument design is tending to become more specialist (to a particular material), the treatment of the basic rheological properties is being successfully extended to a more general range of solids, both metallic and non-metallic in nature. A. J. KENNEDY

539.378

1193. Anisotropic property of single crystal of aluminium. T. MUKAI. *J. Sci. Hiroshima Univ. A,* **15,** 269–72 (*Feb.,* 1952).

Thick single-crystal plates of Al having the crystallographic planes (100), (110) or (111) in their surfaces were prepared and the indentations produced by pressing with steel cones examined. Anisotropy of the indentation was found. H. P. MYERS

539.434

1194. Creep of copper under deuteron bombardment. W. F. WITZIG. *J. appl. Phys.,* **23,** 1263–6 (*Nov.,* 1952).

The creep rate of Cu under deuteron bombardment has been investigated using the 16 MeV external beam of the University of Pittsburgh cyclotron. Measurements were made of the second stage creep rate of a Cu wire under deuteron bombardment at a temperature of 260°C and a loading of 10 000 lb/in². Within the precision of the experiment ±20%, the creep rate during and after bombardments of 10 to 20 hours duration was unchanged from the creep rate preceding bombardment. Theoretical considerations of the type discussed by Slater, predict that with the available deuteron flux of 10^{12} particles per cm² per sec there should be no appreciable change in creep rate. The available deuteron flux cannot displace enough atoms from their normal lattice sites to produce a dislocation

involving a hundred atoms or more; further, the steady-state density of displaced atoms is not enough to impede the motion of those dislocations present in the crystals. While regions of increased local temperature are produced during bombardment, these also should not affect the creep rate. Thus, apparently the considerations of solid-state theory are confirmed and creep rates should not be expected to increase for all metals under bombardment. A.

539.434 : 548.0

1195. Creep of zinc single crystals under direct shear. E. H. WEINBERG. Letter in *J. appl. Phys.*, **23**, 1277 (*Nov.*, 1952).

Tyndall's law [see Abstr. 9052 (1950)], that in time t creep strain $s = at^m$ (a and m constants), is obeyed at least up to $s = 3°$ by crystals with their basal plane parallel to the shear direction. $m \simeq 0{\cdot}6$. Reversing the stress after a creep run allows creep at a stress which is very low and varies with the time between the runs. A. D. LE CLAIRE

539.434 : 548.0

1196. Creep of zinc single crystals. D. O. THOMPSON. Letter in *J. appl. Phys.*, **23**, 1277–8 (*Nov.*, 1952).

See preceding abstract. Tyndall's law is confirmed. $m \simeq 0{\cdot}5$, is independent of the state of the crystal, very little dependent on the stress applied and varies with temperature T as $m = m_0 \exp(-H/RT)$ where $H = 3400$ cals/mole. A. D. LE CLAIRE

539.501

1197. The Weissenberg effect in blown bitumen. K. LAX-WEINER AND R. SCHOENFELD-REINER. Letter in *Bull. Res. Coun. Israel*, **2**, 66 (*June*, 1952).

The effect [Abstr. 1332 (1947)] was observed in an elastic bitumen but not in an inelastic one; hence it is concluded that it is associated with the elasticity of the material. J. E. CAFFYN

539.533

1198. The hardness of metals. D. TABOR. *Oxford, Clarendon Press; London, Oxford University Press* (1951) ix + 176 *pp*.

Review in *Nature* [*London*] **170**, 818 (*Nov.* 15, 1952).

539.533 : 548.0

1199. Anisotropy in mutual grinding of crystals. V. D. KUZNETSOV. *Dokl. Akad. Nauk SSSR*, **85**, *No.* 1, 63–5 (1952) *In Russian.*

Relations exist between the conceptions of hardness as determined by scratching, pendulum sclerometer and mutual grinding tests, and these extend to an existing anisotropy of the crystal hardness as tested by any of these methods. Thus, such an isotropy must also appear in tests by different methods. This is shown for gypsum crystals ($CaSO_4.2H_2O$), belonging to the prismatic class of the monoclinic system. The hardness rosette was first determined by pendulum sclerometer and then by mutual grinding, the ground-down masses of two crystals being in the ratio $M_1/M_2 = 1$ if the directions of rubbing correspond to each other, whereas they are $\neq 1$ if this is not the case. It is thus possible to obtain a hardness rosette relatable to that found by sclerometer, and a similar one if the grinding tests are carried out with a NaCl crystal rubbed against the gypsum crystal. Such anisotropies are, e.g. found on metal crystals taken from rolled sheets, where the hardness varies between the direction of rolling and any other direction at an angle to it, and depends on this angle.

B. F. KRAUS

539.62 : 537.311.3 : 621.89 : 621.317.39

1200. A study of the oil-film formation in gears by electrical resistance measurements. T. B. LANE AND J. R. HUGHES. *Brit. J. appl. Phys.*, **3**, 315–18 (*Oct.*, 1952).

In pursuit of information concerning the nature of lubrication in gears, measurements of the electrical resistance between the meshing teeth of rotating gears have been made using a c.r.o. Photographs of the trace on the screen are shown indicating values of resistance ranging from ∞ to 0. The variation of resistance depends on the load, though the resistance is always lowest where the sliding speed is highest and has its maximum in the neighbourhood of the pitch-line where there is no sliding motion. Absolute values of film-thickness could not be determined. A.

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.124

1201. Rate laws and mechanisms of oxyanion reactions with bases. J. O. EDWARDS. *Chem. Rev.*, **50**, 455–82 (*June*, 1952).

A study of the reactions of oxyanions (e.g. BrO_3^-) with electron donors (e.g. I^-) catalysed by H^+ ions. Four types of rate laws are proposed and several examples of each are given. The nature of the intermediates postulated in these processes and the evidence for their existence are considered. Certain individual reactions are discussed in detail. H. H. GREENWOOD

541.124

1202. Reactions of free radicals with aldehydes. The reactions of methyl and *t*-butoxy radicals with acetaldehyde and acrolein. D. H. VOLMAN AND R. K. BRINTON. *J. chem. Phys.*, **20**, 764–8 (*Nov.*, 1952).

The reaction in the gas phase of radicals derived from the thermal decomposition of *di-t*-butyl peroxide with acetaldehyde and acrolein has been studied. The activation energy for H atom abstraction from acetaldehyde by methyl was found to be $7{\cdot}5 \pm 0{\cdot}3$ kcal/mole. The steric factor was about $3{\cdot}7 \times 10^{-3}$, in agreement with many similar reactions. Evidence for chain ending steps other than the recombination of methyl radicals is given. Acrolein polymerizes as well as decomposes in the presence of radicals. The polymerization follows the kinetics to be expected from chain propagation by radical-monomer interaction and chain termination by radical combination. Evidence that the decomposition may be the splitting off of carbon monoxide from the polymerizing chain is presented. A.

541.124

1203. The stability of the acetyl radical. A. J. C. NICHOLSON. Letter in *J. chem. Phys.*, **20**, 1811 (*Nov.*, 1952).

As the acetyl radicals produced by photolysis of acetone in the presence of iodine combine easily with iodine atoms, the conclusion found by Pitts and Blacet (1952) that the radical is very stable seems incorrect. The low yield of carbon monoxide merely indicates that the combination reaction is faster than the decomposition. A. J. TAYLOR

541.124 : 536.7

1204. Inorganic free radicals in solution. N. URI. *Chem. Rev.*, **50**, 375–454 (*June*, 1952).

A critical survey emphasizing throughout the importance of energetic considerations in the processes discussed. A study of the Haber–Weiss mechanism and of the various proposed modifications is followed by a quantitative discussion of the energetics of the OH and HO_2 radicals and of the O_2^- radical ion. Using these results much thermodynamic data for different types of reactions involving these systems is presented. The following topics are discussed: the transition state for free radical reactions, catalysis and promotion, initiation of polymerization, oxidation by Fenton's reagent. The different mechanisms of photochemical formation of atoms and free radicals with the subsequent reactions, and the significance of free radical reactions in photosynthesis are outlined. Several other related topics are discussed, e.g. chain reactions of ozone, aerobic oxidation, positive ions as unstable intermediate products, free radicals in radiation chemistry and so on. H. H. GREENWOOD

541.124 : 539.155.2

1205. Effect of nuclear substituents on the C^{14}-isotope effect in the saponification of carboxyl-labeled ethyl benzoates at 25°C. G. A. ROPP AND V. F. RAAEN. Letter in *J. chem. Phys.*, **20**, 1823 (*Nov.*, 1952).

Experimental results for electron donating substituents suggest that the isotope effect may be greatest when the largest contributions to the ground state are made by the ionic configurations.

H. H. GREENWOOD

541.124.7

1206. Dissociation of sulphur vapour. II. H. BRAUNE AND E. STEINBACHER. *Z. Naturforsch.*, **7a**, 486–93 (*July*, 1952) *In German.*

For Pt I, see Abstr. 5855 (1951). The spectrophotometric investigation of the absorption bands of S vapour in the visible region has revealed a continuum with a maximum at 5100 Å. When comparing the dependence of its intensity at this wavelength upon pressure and temperature with that obtained for various species of molecules occurring in S vapour, a parallelism has been found between the intensity at 5100 Å and the concentration of the S_4 molecules, calculated by Braune, Peter and Neveling. It is also suggested that the diffuse band system in the short-wave end of the visible region should also be attributed to S_4. F. LACHMAN

541.126

1207. On the solution of the Poisson–Boltzmann equation with application to the theory of thermal explosions. P. L. CHAMBRÉ. *J. chem. Phys.*, **20**, 1795–7 (*Nov.*, 1952).

The theory of thermal explosions originally proposed by Frank–Kamenetzky has been the subject of a number of investigations. The critical condition of inflammability requires the solution of the nonlinear Poisson–Boltzmann differential equation. For the case of a reaction vessel of cylindrical or spherical shape the solution was obtained by previous investigators by numerical integration of the equation. It is shown, however, that the solutions can be obtained in terms of known functions. A.

541.126

1208. Effect of water vapour on explosions of carbon monoxide. D. E. HOARE AND A. D. WALSH. Letter in *Nature* [*London*] **170**, 838–9 (*Nov.* 15, 1952).

The low-pressure reaction at a particular temperature between CO and O_2 is characterized by upper and lower pressure limits for (*a*) explosion, (*b*) glow (i.e. slow oxidation). It has been confirmed that the presence of H_2O vapour has no effect on the lower limits; but, in contradiction of the conclusions of Hadman *et al.* (1932), it raises the upper limits both for explosion and for glow. It has also been found that the explosion peninsula for CO is expanded by small, and contracted again by larger, amounts of CH_4.

A. SCHOFIELD

541.127

1209. Some examples of weak detonations. S. G. REED, JR. Letter in *J. chem. Phys.*, **20**, 1823–4 (*Nov.*, 1952).

It is pointed out that a "weak" detonation wave can be set up (*a*) by condensation of water vapour in air, (*b*) by irreversible condensation of supersaturated steam or nitrogen in a supersonic stream. A "weak" detonation wave is one whose corresponding point on a Hugoniot diagram lies on the lower branch of the Hugoniot curve, below the Chapman–Jouguet point. Such a detonation wave of type (*a*) behaves somewhat similarly to a chemical detonation wave, in that the velocity of sound in the material increases sharply as the wave passes; in type (*b*) waves, however, the sound velocity decreases. A. SCHOFIELD

541.127

1210. The reaction of $Hg(^3P_1)$ with ethylene. B. DEB. DARWENT. *J. chem. Phys.*, **20**, 1673–8 (*Nov.*, 1952).

The reaction of $Hg(^3P_1)$ with ethylene at room temperature has been re-investigated. Special attention was paid to the effects of the concentrations of ethylene and mercury on the reaction velocity. The results are in general agreement with a mechanism which requires the excited ethylene, produced initially, to decompose both in the gas phase and on the wall. The results are also compatible with the suggestion that a significant fraction of the quenching collisions between ethylene and $Hg(^3P_1)$ leads to the formation of metastable $(^3P_0)$ atoms. A.

541.127

1211. The reaction of $Cd(^3P_1)$ with propane at low conversion. P. AGIUS AND B. DE B. DARWENT. *J. chem. Phys.*, **20**, 1679–83 (*Nov.*, 1952).

The reaction of $Cd(^3P_1)$ with propane has been investigated at 300°C under such conditions that the

rates of production of hydrogen and methane are independent of time. The quantum yield of hydrogen production, when corrected for incomplete quenching, is close to unity and is approximately independent of the substrate pressure. The production of methane can be accounted for by the decomposition of propyl radicals. The ratio CH_4/H_2 increases with decreasing pressure of propane; if this ratio varies as $I_a^{\frac{1}{2}}$ (as is the case when the methyl radicals are produced by the thermal decomposition of propyl radicals), the increase may be ascribed to the decreasing absorbed intensity at lower pressures. A.

541.127

1212. Kinetics of decomposition of nitric oxide at elevated temperatures. II. The effect of reaction products and the mechanism of decomposition. H. WISE AND M. F. FRECH. *J. chem. Phys.*, **20**, 1724–7 (*Nov.*, 1952).

For Pt I see Abstr. 3063 (1952). The effects of N and O on the kinetics of decomposition of NO have been investigated. In the temperature region in which the heterogeneous mechanism prevails (at $T < 1000°K$) the presence of N has a marked retarding influence on the reaction rate of NO due to poisoning of the surface. On the other hand, the addition of O results in a marked increase in the rate of decomposition of NO over the entire temperature range studied. At high concentrations of O the following empirical rate expression obtains: $-d[NO]/dt = k_a[NO]^2 + k_b[NO][O_2]^{\frac{1}{2}}$, with an activation energy of 78·2 kcal for the rate-determining step. It is apparent therefore that the decomposition of NO is autocatalytic. On the basis of these experimental observations a mechanism is proposed involving a chain propagated by the atomic species formed in the reaction. A.

ELECTROCHEMISTRY 541.13

541.132

1213. The hydrogen ion in aqueous solution. G. SUTRA. *C.R. Acad. Sci.* [*Paris*] **235**, 957–8 (*Oct.* 27, 1952) *In French.*

The H^+ ion in water appears to be a proton encaged by water molecules, and is not combined in the form $(H_3O)^+$. Many properties of acid solutions are in accord with this conception. An explanation is now given as to why the positively charged proton cannot combine with the dipolar H_2O molecule, which is based on the average movement of the proton within the cage. The calculations are in agreement with data based on limiting conductivity; it follows from them that the proton is reflected at the cage walls. H. H. HODGSON

541.133 : 534.321.9

1214. The influence of ultrasonics on the electrical conductivity of $CuSO_4$ and $Pb(NO_3)_2$ solutions. K. ALTENBURG AND G. DÖRR. *Z. phys. Chem.*, **200**, 158–61 (*Aug.*, 1952) *In German.*

Measurements of the electrical conductivity of aqueous solutions of $CuSO_4$ and $Pb(NO_3)_2$ have shown that the influence of ultrasonics is very small and never greater than 1%. T. C. TOYE

541.135.4

1215. Contribution to the study of the diffusion of ions through metallic coatings. M. BONNEMAY, H. MAKRAM AND J. ROYON. *C.R. Acad. Sci.* [*Paris*] **235**, 955–7 (*Oct.* 27, 1952) *In French.*

The porosity of electrolytic coatings is investigated by two different methods, viz. (1) An electrolytic procedure, which consists in following the potential-time of a coated metal electrode immersed in a solution of a salt of the metal. Curves are given for copper coated with different thicknesses of chromium immersed in a solution of 2N.$CuSO_4$. (2) By the use of radioactive tracers, whereby activity commences only after a period which depends on the properties of the coatings; the log of the period appears to be proportional to the thickness. This period is also given by the abscissa of the maximum of the potential-time curve above. H. H. HODGSON

541.135.5

1216. Isotopic effect of the electrolytic migration of zinc ions in fused zinc bromide. A. KLEMM, E. LINDHOLM AND A. LUNDÉN. *Z. Naturforsch.*, **7a**, 560–4 (*Aug.*, 1952) *In German.*

The isotopic effect of cationic migration is investigated for $PbBr_2$ and $ZnBr_2$ by means of the cell: cathode C/Pb/$PbBr_2$/$ZnBr_2$/anode C + Br_2. Apparatus and experimental details are described. At the boundary between $PbBr_2$ and $ZnBr_2$, the light Zn isotope is found to be enriched (period 2·4 days; current strength 140 mA; c.d. 2·75 A/cm²; displacement of Br relative to Zn $2m$; temp. in separation tube 500°C). A survey of relevant theory and a discussion of all available data are included [see also Abstr. 2049 (1952)]. The mass effect found, $\mu = -0·111$, corresponds with a derived semi-empirical formula. H. H. HODGSON

541.135.5

1217. Cleaning of electrolytically polished metallic surfaces by means of cathodic spraying. H. WESEMEYER AND H. RAETHER. Note in *Naturwissenschaften*, **39**, *No.* 17, 398 (1952) *In German.*

Electrolytically polished surfaces of copper and zinc are efficiently cleaned from adherent oxide films due to the electrolyte, or traces of phosphorus if orthophosphoric acid is used in the bath, by cathode spraying, with hydrogen as filling gas for the discharge. H. H. HODGSON

541.135.6

1218. Physical and chemical characteristics of oxygen compounds of manganese correlated with their catalytic and depolarizing properties. J. BRENET AND A.-M. MOUSSARD-BRIOT. *Rev. gén. Elect.*, **61**, 405–10 (*Sept.*, 1952) *In French.*

The problem of changes in activity of MnO_2 when used as a depolarizing agent in cells is investigated. Physico-chemical and radiocrystallographic methods have enabled the properties and structure to be followed during depolarization of specimens of MnO_2 which have been subjected to various thermal treatments prior to use. The results appear to be related to observations on catalytic behaviour. Two tables of data deal respectively with the development of electrochemical potential of a specimen of MnO_2 before and after treatment, and of the capacity and

duration of discharge of a cell after deactivation of the depolarizer. Microphotometric curves for active and deactivated MnO_2 are included. 10 refs.

H. H. HODGSON

541.136

1219. Relationship between the electrical and geometrical characteristics of an electrochemical cell with manganese dioxide as depolarizer. J. BRENET. *C.R. Acad. Sci.* [*Paris*] **235**, 615–17 (*Sept.* 22, 1952) *In French.*

A general expression is derived which connects the current intensity of an electrochemical cell and its internal resistance with its dimensional and geometrical characteristics in order to deduce maximum capacity. This relationship takes a very simple form for the case of a cell having cylindrical symmetry.

H. H. HODGSON

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

1220. On the dependence of the molecular quantum absorption on the light intensity in photochemical processes. K. H. HAUSSER AND U. WEGNER. *Z. Naturforsch.*, **7a**, 493–7 (*July*, 1952) *In German.*

It has been observed that the graph showing the fractional yield as a function of the number of quanta absorbed per mol. for the photochemical red → yellow transformation of triphenylformazane has the character of a single collision reaction, but is dependent upon the intensity of the incident light. It is concluded that this reaction belongs to the double collision class, but proceeds in two stages. If the transition state is unstable and if the absorption cross-sections of the partial reactions are sufficiently different, the character of the curves obtained may be changed in such a way. Formulae to describe the reaction are derived and sets of theoretical curves obtained. Some reaction parameters are found by comparison of the latter with the experimental curves. Values are also found for the half-lifetime and the absorption cross-section of the unstable transition state, which cannot be obtained experimentally. A. J. TAYLOR

541.15

1221. Action of X-rays on aqueous solutions of perchloric acid. B. MILLING, G. STEIN AND J. WEISS. Letter in *Nature* [*London*] **170**, 710 (*Oct.* 25, 1952).

The amount of chlorate formed during irradiation of aqueous solutions of perchloric acid by 200 kV X-rays is directly proportional to the concentration of the acid up to 2 M solution, and it is not affected by the addition of ceric salts. If ferrous salts are present, chloride is formed in an amount equivalent to the chlorate formed in the absence of ferrous salt. Less hydrogen gas is formed than would be equivalent to the conversion ferrous → ferric. It appears that OH radicals formed from water by the irradiation are unable to react with perchlorate. C. B. ALLSOPP

541.15

1222. Some effects of cobalt gamma-radiation on aqueous benzene solutions. T. J. SWORSKI. Letter in *J. chem. Phys.*, **20**, 1817–18 (*Nov.*, 1952).

Air-saturated aqueous solutions of benzene are irradiated from a Co^{60} source. The formation of phenol is followed by a new spectrophotometric technique which is independent of the presence of H_2O_2, and is compared with the formation of H_2O_2. The initial rate of H_2O_2 formation is enhanced by benzene. There is a discontinuity in the curve of phenol formation at the point when H_2O_2 begins to disappear. C. B. ALLSOPP

541.1

1223. The dissociation of ethyl bromide and iodide by neutron capture. S. WEXLER AND T. H. DAVIES. *J. chem. Phys.*, **20**, 1688–94 (*Nov.*, 1952).

A study has been made of recoil halogen species ejected from gaseous ethyl bromide and iodide after neutron capture. The results demonstrate that a fraction of the radio-halide fragments carry a positive charge. The fraction charged is 12% for the 4·4 hr Br^{80m}, 25% for the 36 hr Br^{82} and 50% for the 25 min I^{128}. The corresponding estimate for the 18 min Br^{8} is very approximately 18%. The positive charges are attributed to internal conversion processes in the stabilization of the compound nucleus formed by neutron capture. The fraction of positive recoil ions is interpreted as the minimum fraction of neutron capture processes which are followed by an internal conversion process. A comment is made upon the possible significance of the ions in the study of chemical reactions induced by radiative neutron capture. A study of the 18 min Rb^{88} from β-decay of the 2·8 hr Kr^{88} was made using the procedures and equipment employed in the halogen experiments. The results show that all Rb^{88} atoms are positively charged as expected. A

541.1

1224. Negative pion activation of bromine. T. T. SUGIHARA AND W. F. LIBBY. *Phys. Rev.*, **88**, 587– (*Nov.* 1, 1952).

Radiochemical studies of the reactions of π^- mesons with Br, Ag and the light elements present in photographic emulsions should assist considerably in the interpretation of data obtained with photographic plates. The results for Br with 122 MeV negative pions expending their full range in the element include: Peak yield of about 7% for As^{76} (ejection of 1 proton and 2 or 4 neutrons depending on which Br isotope absorbs the pion); the ratio of the number of neutrons to the number of protons ejected was three to four in the most probable cases; the distribution of radioactivities appears to be reconcilable with photographic plate data if one guesses that the Ag data will resemble those for Br. A

DISPERSIONS . COLLOIDS . ADSORPTION 541.18

541.182

1225. Diffusional processes in the growth of aerosol particles. H. L. FRISCH AND F. C. COLLINS. *J. chem. Phys.*, **20**, 1792–1803 (*Nov.*, 1952).

Various theoretical problems encountered in the diffusional growth process of aerosol particles have been investigated. Fick's differential law with a modified boundary condition has been shown t

approximately valid even where the mean free path of the diffusing molecules is long compared to the radius of the aerosol droplet. A new method has been developed for handling the case of a plurality of competing sinks in the diffusion field. The contribution of a time-dependent uniform source function to the flux into the sinks has been calculated by a method which enables account to be taken of the transient in concentration due to the diffusion process. Such a time-dependent source function representing a change in the number of molecules available for diffusion, will arise because of temperature changes in the diffusion field in the aerosol growth problem.

A.

541.182.5

1226. Inhibition of the gelation of gelatin by autoclaved gelatin. R. J. GOLDBERG. Letter in *J. chem. Phys.*, **20,** 1816 (*Nov.*, 1952).

It has been found that the special Knox gelatin solution used clinically as a "blood substitute," when autoclaved for 500 min at 15 lb pressure, has a tendency to inhibit the gelation of the same gelatin autoclaved for 20 min only. This finding agrees with theoretical considerations developed by the author.

F. LACHMAN

541.182.6

1227. Stability of lyophobic sols. V. B. VOUK. Letter in *Nature* [*London*] **170,** 762 (*Nov.* 1, 1952).

Ostwald's theory that the coagulation of a lyophobic colloid takes place at an approximately constant value of the activity coefficient of the coagulating ion may be derived from the Verwey–Overbeek treatment.

R. F. BARROW

541.183

1228. Extension of the law of Traube–Duclaux to the adsorption of saturated fatty acids on paraffin. L. GUASTALLA. *C.R. Acad. Sci.* [*Paris*] **235,** 941–3 (*Oct.* 27, 1952) *In French.*

By investigating the adsorption of fatty acids on the free surface of their aqueous solutions and on solid paraffin [see Abstr. 7644 (1952)] it has been shown that the Traube–Duclaux law can be extended to cover both cases. For the free liquid surface the Traube–Duclaux coefficient is 3 and becomes 3·85 for adsorption of the same saturated acids on to paraffin.

J. IBALL

541.183 : 538.082

An apparatus for the simultaneous determination of adsorption isotherms and magnetic susceptibility. *See Abstr.* 948

CHEMICAL STRUCTURE 541.2/.6

541.634 : 539.132

1229. The thermal *trans-cis* isomerization of dideuteroethylene. B. S. RABINOVITCH, J. E. DOUGLAS AND F. S. LOONEY. Letter in *J. chem. Phys.*, **20,** 1807–8 (*Nov.*, 1952).

Experimental studies at low pressures yield the normal frequency factor and high activation energy characteristic of the singlet mechanism of reaction. The activation energy can then be identified with the lowest singlet state (N') for perpendicular ($\phi = \pi/2$) ethylene. It may therefore be used to deduce the parameters in the semitheoretical (quantum mechanical) calculations for ethylene. It also yields data on carbon-carbon bond dissociation energies.

H. H. GREENWOOD

541.634 : 539.132

1230. The sodium photosensitized isomerization of cis-butene-2. W. MACF. SMITH. Letter in *J. chem. Phys.*, **20,** 1808 (*Nov.*, 1952).

The energy donated by a sodium atom in the ^3P excited state to a butene molecule during a quenching collision is greater than the highest recorded energy of activation for cis-trans isomerization of ethylene derivatives. An experiment is described which indicates isomerization of less than 2%. This suggests an energy of activation higher than previously supposed, or alternatively a rapid removal of energy from the region of the double bond. H. H. GREENWOOD

541.67

1231. Rotativities of ethane and saturated hydrocarbons. R. DE MALLEMANN AND F. SUHNER. *C.R. Acad. Sci.* [*Paris*] **235,** 643–5 (*Sept.* 29, 1952) *In French.*

The magnetic rotativities of 15 saturated hydrocarbons have been measured in the gaseous and liquid states for $\lambda = 578$ mμ. A mean increment of 55 units in the molar rotativity per CH_2 group is encountered on ascending the homologous series. The experimentally observed rotativity of *cyclo*-hexane is in agreement with this value. G. I. W. LLEWELYN

CHEMICAL PROCESSES 542.9

542.923 : 539.27

1232. Control of the chemical action of the beam during the recording of electron diffraction patterns. The case of hydrated cobaltous chloride. R. LECUIR AND [MME] R. LECUIR. *C.R. Acad. Sci.* [*Paris*] **235,** 946–8 (*Oct.* 27, 1952) *In French.*

Observation of the *in vacuo* deomposition of a salt upon heating [see Abstr. 4718 (1952)] is disturbed by the action of the electron beam, which can itself produce the same effects if the energy absorbed by the specimen is too large. A direct measurement of the proportion of the beam current absorbed by the specimen was made, and used to ensure that beam effects were negligible. The results then obtained with $CoCl_2.6H_2O$ are given. R. S. PEASE

CHEMICAL ANALYSIS 543/545

545.32

1233. Electrometric determination of ozone at high dilutions. J. N. PRING AND G. M. WESTRIP. *Nature* [*London*] **170,** 530–1 (*Sept.* 27, 1952).

An electrometric method of determining ozone is described. It is highly sensitive and can be carried out readily with a portable apparatus. The

reaction employed is the liberation of bromine from hydrobromic acid by ozone. The cell used was Pt wire/3N H_2SO_4 and N KBr/3N H_2SO_4 saturated with Hg_2SO_4/Hg. A. J. MEE

545.8 : 539.16.08

1234. Detection and estimation of carbon in steel by the use of artificial radioactivity. I. CURIE. *J. Phys. Radium*, **13**, 497–8 (*Nov.*, 1952) *In French.*

Samples of steel were irradiated with 6·7 MeV deuterons. N^{13} with 10 min half-life was produced by the carbon and was readily detected, for example, photographically. F. R. HOLT

545.822

1235. Wavelength tables of sensitive lines. L. H. AHRENS. *Cambridge, Mass.: Addison-Wesley* (1951) 86 *pp.*

Review in *Science*, **116**, 287 (*Sept.* 12, 1952): "These tables are of great value for the analyst dealing with the spectrographic d.c. arc analysis of compound materials such as rocks, soils and minerals. The main table contains the wavelengths of the most sensitive lines of 68 elements and information about relative intensities and sensitivities, and excitation potentials. The most valuable feature of the book is the listing of all possible interfering lines of other elements occurring in the neighbourhood of each sensitive line within the range of about ±0·5 Å. A smaller separate table lists the most sensitive lines of the rare earth elements."

CRYSTALLOGRAPHY 548

548.0 : 537.226.2 : 537.228.1 : 539.32

1236. The piezoelectric, dielectric, and plastic properties of $ND_4D_2PO_4$ (deuterated ADP). W. P. MASON AND B. T. MATTHIAS. *Phys. Rev.*, **88**, 477–9 (*Nov.* 1, 1952).

Measurements of the dielectric constants, piezoelectric constants and elastic constants have been made for the crystal $ND_4D_2PO_4$ (heavy water ADP). This crystallizes in the same form as normal ammonium dihydrogen phosphate (ADP) but has a transition at −31°C which is 94° higher than that for normal ADP. From the form of the crystal below the transition temperature, it is inferred that the transition is an antiferroelectric one with one of the "*a*" crystallographic axes as the antiferroelectric axis. The crystal has a zero temperature coefficient of frequency at 0°C, and it may be of use in transducers and mechanical filters. A.

548.0 : 537.226.2 : 537.228.1 : 539.32

1237. Properties of a tetragonal antiferroelectric crystal. W. P. MASON. *Phys. Rev.*, **88**, 480–4 (*Nov.* 1, 1952).

In order to interpret the properties of the tetragonal crystal $ND_4D_2PO_4$ (deuterated ADP) a thermodynamic treatment has been developed which relates the observed crystal structure change and the dielectric constant change at the transition temperature to the appearance of spontaneous polarization. For an antiferroelectric crystal, the average spontaneous polarization is zero, being oppositely directed for adjacent layers, but the square of the spontaneous polarization is large. This results in quadratic strain components which cause a change in the crystal structure below the transition temperature. It is shown that the change observed is consistent with an antiferroelectric arrangement with one of the *a* axes being the antiferroelectric axis. The dielectric constants in all three directions suffer a large drop below the transition temperature. A.

548.0 : 539.211

Plastic deformation features on cleavage surfaces of metal crystals. *See Abstr.* 1164

548.5

1238. Interferometric examination of quartz crystals. S. AMELINCKX. *Natuurwet. T.*, **33**, 169–74 (1951).

A number of quartz rhombohedral faces were investigated by multiple-beam interferometry. Triangular growth pyramids, different in shape and orientation for right- and left-handed crystals, as well as for positive and negative rhombohedral faces, are found, and interferograms are shown for each. The structure of these pyramids is illustrated. The inclination of their faces with respect to the ideal rhombohedral face is variable, but variation is the same for all pyramids on one face. An interpretation of these phenomena, based on Frank's theory of crystal growth, is given. BRITISH ABSTRACTS

548.5

1239. The epitaxial growth of germanium on rocksalt. L. E. COLLINS AND O. S. HEAVENS. Letter in *Proc. Phys. Soc.* [*London*] *B*, **65**, 825–6 (*Oct.*, 1952).

Results of a study of the growth of Ge films, evaporated *in vacuo* from a Ta boat in the specimen chamber of an electron diffraction camera on the (100) cleavage face of rocksalt at temperatures up to 530°C, are briefly reported. Rates of deposition used were 5–100 Å/sec. The electron beam inhibits the film deposition but does not affect its structure. First signs of an orienting influence of the substrate occurs at 490°C. At low rates the film reflectivity is that of bulk Ge, at high rates the films are grey and lustreless. For higher temperatures high rates of evaporation are needed and the degree of orientation increases. The films were up to 3000 Å thick and the structure did not depend on the thickness.

S. WEINTROUB

548.5

1240. Perfect demarcation of the diamond crystal structure in germanium. S. A. ROBINSON, P. L. OSTAPKOVICH, E. S. SCHLEGEL AND C. P. GAZZARA. *Science*, **116**, 362–4 (*Oct.* 3, 1952).

Visible observation of the top surface of molten Ge during crystallization has shown that nucleation commences from the top and is associated with

definite geometric patterns of triangular, hexagonal or diamond form, depending on the plane of growth. The growth spreads both horizontally and vertically. By hooking out crystals from the melt it was established that single crystal Ge has a completely developed octahedral form. Photographs of the growing crystal are given. S. WEINTROUB

548.5

1241. Spiral growth on graphite. F. H. HORN. Letter in *Nature* [*London*] **170,** 581 (*Oct.* 4, 1952).

Spirals can be detected on some graphites but not on others; this fact may be useful geologically and also in explaining polytypism. A. R. STOKES

548.5

1242. Growth spirals and their relation to crystal habit as illustrated by apatite. S. AMELINCKX. Letter in *Nature* [*London*] **170,** 760–1 (*Nov.* 1, 1952).

Completely differently shaped growth spiral patterns from those reported in Abstr. 6160 (1952) have been observed on tabular colourless apatite crystals from Sulzbachtal. One pattern is illustrated. The main growth fronts have a step-height of 140 ± 20Å. The spirals are oriented in the same way on the six prism faces, indicating a hexad symmetry axis. Both in the previous and present patterns there is a striking similarity between the outline of the prism faces and the shapes of the spiral growth fronts and it is concluded that crystal habit results from the growth spirals. S. WEINTROUB

548.5

1243. Relations between the symmetry of a crystal and that of the growth spirals which it can exhibit. S. AMELINCKX. Note in *Naturwissenschaften,* **39,** *No.* 18, 425–6 (1952) *In French.*

The author's observations on a large number of SiC crystals show that the relation between the symmetry of a crystal and its growth spirals is not as simple as made out by Kalb and Wittborg [Abstr. 7372 (1951)]. Examples are given, and discussed, of observed differences. Frequently, due to an imperfect dislocation in the growth, the superficial layer differs in structure from the remainder, and different regions of the same crystalline face belong to different types. S. WEINTROUB

548.5

1244. Preparation of germanium single crystals. L. ROTH AND W. E. TAYLOR. *Proc. Inst. Radio Engrs,* **40,** 1338–41 (*Nov.,* 1952).

Single crystals have been prepared by two methods using a vacuum furnace ($\sim 5 \times 10^{-6}$ mm Hg pressure) with induction heating. In the first method nucleation is induced at the upper surface of the melt by producing the necessary heat gradient, and a single crystal is grown in the crucible by controlling the rate of cooling. In the second method molten Ge is seeded with a single crystal and is withdrawn as it solidifies in the orientation of the seed crystal. Seeds orientated with the (111), (100) and (110) planes parallel to the surface of the melt have been used and well-developed crystal faces are obtained. Single crystals of pure Ge and Sb or In-doped Ge do not wet the crucible; Al-doped Ge adheres to the crucible. Resistivity gradients may be greatly reduced by repeated recrystallizations. Pure Ge of about 55 ohm-cm resistivity can be obtained in this way. A.

548.5

1245. Silicon single crystal rods. H. KLEINKNECHT. Note in *Naturwissenschaften,* **39,** *No.* 17, 400–1 (1952) *In German.*

The crystals, about 10 cm long and a few mm wide, were grown by the Czochralski method in a hydrogen atmosphere. It was noticed that solid Si at the m.pt. radiates more strongly than the liquid metal. The form of the crystals is illustrated and discussed. The rod axis coincides in general with the [110] direction. Twinning occurs and always in the (111) planes. The crystallization removes impurities, leaving mainly Cu of about 10^{-2}–10^{-3} %. The crystal rod was *p*-type for 1 cm at beginning, then *n*-type almost to the end which was again *p*-type. S. WEINTROUB

548.522

1246. The growth of crystals of the hexagonal metals from their vapours. A. J. FORTY. *Phil. Mag.,* **43,** 949–56 (*Sept.,* 1952).

The techniques for preparation of well-developed growth surfaces of crystals of the hexagonal metals are described. A subsequent examination of the surfaces under the phase contrast microscope reveals growth steps which are probably monomolecular. Spiral growth hills on basal surfaces of Mg and Cd crystals indicate that these grow by the screw dislocation mechanism. The growth patterns on basal surfaces of Zn can only be explained by a spreading of (0001) monolayers, which are catalysed by a foreign nucleus, probably ZnO. Similar nuclei incorporated in Zn crystals during growth are revealed by evaporation from the habit faces. The possibilities of performing plastic deformation experiments with these crystals are discussed. A.

MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 530.145

1247. The Franck–Condon principle and its application to crystals. M. LAX. *J. chem. Phys.,* **20,** 1752–60 (*Nov.,* 1952).

The semiclassical Franck–Condon principle is shown to be related to the more rigorous ("exact") quantum mechanical perturbation formula in the following ways: (1) the Franck–Condon formula can be derived from the "exact" formula by using a mean value approximation or by neglecting certain commutators; (2) if the electric dipole moments are treated as approximately independent of position, the Franck–Condon and the "exact" absorption (or emission) spectrum have the same zeroth, first and second moments, i.e. the same integrated spectrum, mean absorption frequency and breadth; (3) the errors in higher moments than the second become relatively unimportant at high temperatures. If the electron-nuclear interaction is sufficiently strong the errors are unimportant even at absolute zero. The use of a quasi-molecular description in a many-particle problem is found to be possible only if the

masses or stiffnesses are allowed to be temperature dependent. A detailed analysis is made of the case in which the energy difference between the two electronic states is a linear function of the vibrational co-ordinates—and the latter are describable by normal modes. "Exact" formulae for the absorption and emission spectrum are obtained. A.

548.7

1248. The motion of slow electrons in polar crystals. T.-D. LEE AND D. PINES. Letter in *Phys. Rev.*, **88,** 960 (*Nov.* 15, 1952).

The low-lying energy levels of a conduction electron in a polar crystal have been investigated using a variational technique due to Tomonaga [Abstr. 2981 (1949)]. The results obtained are in agreement with previous work in the case of weak coupling, but appear to be superior to previous work if the coupling is no longer weak. P. T. LANDSBERG

548.7 : 537.12

1249. On the theory of polarons. S. V. TYABLIKOV. *Zh. eksper. teor. Fiz.*, **22,** *No.* 5, 513–19 (1952) *In Russian.*

See also Abstr. 2069 (1950). An attempt is made to establish equations describing the behaviour of electrons in crystal lattices by taking into account the polarization created by the electrons themselves. Conditions are examined for the application of approximate methods of calculation. In the case of weak bonds values are given characterizing the properties of electrons in a few crystals. Putting $\varepsilon' = \sqrt{(\beta e^2 k_0/\pi\hbar\omega)}$, $k_0 = 2\sqrt{(m_e\omega/\hbar)}$, $\varepsilon^1\varepsilon^2 = \sqrt{(2/\pi)}$, and using $\beta = 1/k_0 - 1/k$, the author obtains ω, limiting frequency of lattice, μ/m_e, μ = mass of polaron, m_e, effective mass of electron in periodic field of lattice, α, exponent of wave function of electron, and R_e, the effective radius of the polaron, in the following cases:

	m_e/m	$R_e \times 10^8$	$1/\alpha$	m_e/m	$R_e \times 10^8$
Cu_2O	1	6·6	7·9	1·3	6·2
KI	1	17	4·7	2·17	14·2
KBr	1	18	3·6	1·97	14·0
KCl	1	16	3·1	1·95	13·6

J. EWLES

548.7

1250. Speculation on the formation of *F*-centers during irradiation. J. J. MARKHAM. *Phys. Rev.*, **88,** 500–9 (*Nov.* 1, 1952).

It is suggested in this paper that X-ray and radium radiation cause three effects on alkali halide crystals, namely, to produce free electrons, free holes and single-ion vacancies. It is further assumed that the single-ion vacancy results from a local distortion of the lattice rather than a diffusion of vacancy pairs from outside the crystal. This postulate explains qualitatively various colour centre phenomena observed at low temperatures and leads to no obvious contradictions. Some rough calculations on this model have been made. Further experimental verification is required. A.

548.7 : 537.531 : 535.345

1251. Color centers in alkali halides at 5°K. W. H. DUERIG AND J. J. MARKHAM. *Phys. Rev.*, **88,** 1043–9 (*Dec.* 1, 1952).

Reports experimental data on the effect of X-raying NaCl, KCl and KBr at 5°K (approximately liquid helium temperature). These crystals, grown by Harshaw, were exposed to X-rays (50 kV at 20 and 48 mA) at 5°K, and the absorption spectra were measured from 210 mμ to 1100 mμ. A large concentration of *F*-centres was produced after an exposure of 15 min. The *F*-centre is narrower than those obtained in additively coloured crystals at 20°K. This difference in width also occurs in crystals X-rayed at 78°K. The narrowing of the *F*-band does not seem to be due to the temperature difference, i.e. 5°K and 20°K. No bands were observed to the infrared with the exception of a small *F'*-band in NaCl and KBr. Bands which were not known previously were obtained to the ultraviolet. Some bands decrease on warming to 78°K while others grow. A.

548.7 : 535.5

1252. Investigation of various modifications of hexamethylbenzene in polarized light. V. L. BROUDE. *Zh. eksper. teor. Fiz.*, **22,** *No.* 5, 600–3 (1952) *In Russian.*

The colour change on cooling due to a variation of the birefringency and the reversal of this process on heating proves the occurrence of phase transformations. The measured phase equilibrium temperature is 113 ± 3°K and corresponds to the peak of the specific heat curve at about 108°K. The low-temperature modification of the hexamethylbenzene has directions of quenching and of the greatest refractive index invariant against the phase transformation; thus a crystal dark between crossed nicols remains so after the transformation. The phase which is metastable at liquid nitrogen temperature, and the low-temperature phase, were found to differ. They are the results of the excitation of the same molecule placed in different lattices. It is natural to assume that the "molecular" bands of these spectra correspond to each other, and the comparison of these bands in the spectra of both phases should indicate the orientation of the molecules relative to the axes of the lattice. The low-temperature component has a higher intensity of the oscillations of the optical vector at right angles to the edge $\bar{b}$, and a greater red-shift, witnessing to denser packing of this phase, whereas the greater intensity normal to edge $\bar{b}$ clearly indicates a variation of the orientation of this direction relative to the plane of the molecule ring. Thus the molecule turns about the plane $\overline{ab}$ in the phase transformation. Probably the elementary cell contains several molecules in mirror-symmetrical arrangement.

B. F. KRAUS

548.73/.74 : 539.26/.27

X-ray and electron investigation of materials. *See Abstr.* 1179–86

548.73

1253. Summarized proceedings of a conference on X-ray analysis—Edinburgh, April, 1952. C. A. BEEVERS AND A. E. DE BARR. *Brit. J. appl. Phys.*, **3,** 305–6 (*Oct.*, 1952).

A conference at which developments in X-ray crystallography were discussed in 45 papers. X-ray methods in industry, particularly chemical and metallurgical, were considered and also recent advances in X-ray technique. Research papers covered recent developments in X-ray physics, metallurgy and chemical subjects. A. E. DE BARR

548.73 : 535.339

1254. Point-focus monochromator for X-rays. J. DESPUJOLS. *C.R. Acad. Sci.* [*Paris*] **235**, 716–18 (*Oct.* 6, 1952) *In French.*

Describes a doubly-curved monochromator made from an Al single crystal. J. THEWLIS

548.733

1255. Achromatic arrangement for the determination of X-ray line profiles. A. GUINIER AND F. SÉBILLEAU. *C.R. Acad. Sci.* [*Paris*] **235**, 888–90 (*Oct.* 20, 1952).

The X-ray beam is reflected by a bent quartz crystal and then by a powder layer in such a way that broadening due to wavelength spread is eliminated. A. R. STOKES

548.735.4

1256. An algebraic method of calculating the signs of the structure factors in X-ray crystallography. J. GARRIDO. *Rev. Mexicana Fis.*, **1**, 4–10 (*April*, 1952) *In Spanish.*

For a centrosymmetric structure consisting of n similar atoms it is possible in principle to obtain the signs of the unitary structure factors $U(h, k, l)$, $U(2h, 2k, 2l)$, . . . $U(nh, nk, nl)$ (say $U_1, U_2, \ldots U_n$) by purely algebraic methods if the $|U|$'s are known. For example, if $n = 2$, the sign of U_2 is $|U_2|^{-1}(|U_1|^2-2)$. Explicit relations are given for $n = 2$, 3, 4, but they become very complex. Only in rare cases will the precision of the U's be great enough to allow the use of the method. A. J. C. WILSON

548.735.44

1257. Improvements in optical Fourier synthesis. A. W. HANSON. Letter in *Nature* [*London*] **170**, 580 (*Oct.* 4, 1952).

See Abstr. 6183 (1952). Corrected doublet lenses have been fitted, giving greatly improved resolution. The number of Fourier terms has been increased. A. R. STOKES

548.736.1

1258. Structure of white phosphorus: single crystal X-ray examination. D. E. C. CORBRIDGE AND E. J. LOWE. Letter in *Nature* [*London*] **170**, 629 (*Oct.* 11, 1952).

Crystals obtained by sublimation were photographed at −30°C. A body-centred cubic cell with $a = 18{\cdot}5$ Å is found; this does not agree with Natta and Passerini (1930). A. R. STOKES

548.736.3

1259. On the crystal structure of nickel oxide. Y. SHIMOMURA AND Z. NISHIYAMA. *Mem. Inst. Sci. Industr. Res. Osaka Univ.*, **6**, 30–4 (1948).

NiO prepared by heating Ni foil in air at 980°C is cubic if the oxide film remains in contact with metallic Ni, but is rhombohedral if the Ni is all consumed. It is thought that stoichiometric NiO is cubic, but NiO with vacant Ni sites becomes rhombohedral. The vacant sites are possibly ordered. NiO prepared by decomposition of Ni nitrate at 1350° is rhombohedral, with $a = 4{\cdot}16768$ Å (?kX), $\alpha = 90° 3{\cdot}8'$ [see also Abstr. 4042 (1948)]. A. J. C. WILSON

548.736.3

1260. The structure of nickel boride NiB. P. BLUM. Letter in *J. Phys. Radium*, **13**, 430–1 (*July–Aug.–Sept.*, 1952) *In French.*

Orthorhombic, *Cmcm*, $a = 2{\cdot}925$, $b = 7{\cdot}396$, $c = 2{\cdot}966$ Å, $Z = 4$, $D_x = 7{\cdot}13$, all atoms in (*c*) $(0, y, \frac{1}{4}$, etc.) with $y = 0{\cdot}146$ for Ni and $0{\cdot}440$ for B. A. J. C. WILSON

548.736.3 : 542.936

1261. Thermal transformations of the aluminas and their hydrates. M. K. B. DAY AND V. J. HILL. Letter in *Nature* [*London*] **170**, 539 (*Sept.* 27, 1952).

A scheme is proposed for the stages of dehydration of gibbsite and bayerite to α-alumina. A. R. STOKES

548.736.3

1262. An X-ray diffraction study of the hafnium-hydrogen system. S. S. SIDHU AND J. C. MCGUIRE. *J. appl. Phys.*, **23**, 1257–61 (*Nov.*, 1952).

The Hf–H system at room temperature consists of three phases. The lattice parameters of the Hf metal used in this investigation and of the three phases are as follows: Hf, $a_0 = 3{\cdot}200$ Å, $c_0 = 5{\cdot}061$ Å and $c = 1{\cdot}58$; deformed cubic phase, $a_0 = 4{\cdot}702 \pm 0{\cdot}012$ Å, $c_0 = 4{\cdot}678 \pm 0{\cdot}012$ Å and $c = 0{\cdot}995$; face-centred cubic phase, $a_0 = 4{\cdot}708 \pm 0{\cdot}002$ Å; and face-centred tetragonal phase, $a_0 = 4{\cdot}882 \pm 0{\cdot}002$ Å, $c_0 = 4{\cdot}384 \pm 0{\cdot}002$ Å and $c = 0{\cdot}898$. The deformed cubic phase extends up to $HfH_{1{\cdot}53}$ and converts into the face-centred cubic phase between $HfH_{1{\cdot}53}$ and $HfH_{1{\cdot}70}$. The face-centred cubic phase transforms into the tetragonal phase between $HfH_{1{\cdot}80}$ and $HfH_{1{\cdot}87}$. The tetragonal phase extends up to $HfH_{1{\cdot}98}$. A.

548.736.5

1263. Crystal structure of $BaFe_{18}O_{27}$. P. B. BRAUN. Letter in *Nature* [*London*] **170**, 708 (*Oct.* 25, 1952).

The structure is hexagonal, with $a = 5{\cdot}88$ Å, $c = 32{\cdot}84$ Å, and is built up like those of the magneto-plumbite structure $BaFe_{12}O_{19}$. A. R. STOKES

548.736.5

1264. A study of substances with the structure of a spinel type. H. TAZAKI AND S. KUWABARA. *J. Sci. Hiroshima Univ. A*, **15**, 263–8 (*Feb.*, 1952).

See also Abstr. 5351 (1952). CuO and γ–Al_2O_3 were heated together to form $CuAl_2O_4$, the reaction being studied at temperatures up to 950°C, and at air pressures from 10^{-3} to 10^3 mm Hg, and shown to be dependent upon both temperature and pressure. The mixtures were heated for various times and the products examined by X-rays and electron diffraction. A range of experiments, some at higher temperatures and atmospheric pressure, were performed with Zn, Fe, Sn, Mg instead of Cu, and Fe, Mg, Zn instead of Al in the above. M. R. HOPKINS

548.737

1265. Preliminary study of the structure of $Te(CH_3)_2I_2$. E. E. GALLONI AND J. PUGLIESE. *Rev. Un. Mat. Argentina*, **15**, 73 (1951) *In Spanish.*

Monoclinic, $P2_1/c$, $a = 12{\cdot}26 \pm 3$, $b = 21{\cdot}89 \pm 4$, $c = 9{\cdot}46 \pm 4$ Å(?), $\beta = 72° 24' \pm 10'$, $Z = 12$. No details. A. J. C. WILSON

548.737

1266. Diffraction of X-rays by naphthalene in the solid state and in the liquid state. F. CENNAMO. *R.C. Accad. Naz. Lincei*, **12**, 294–8 (*March*, 1952) *In Italian.*

Powder photographs and the diffraction pattern of liquid naphthalene at 90°C are compared by micro-

photometry. The five rings 001, 110, 002, 11$\bar{1}$, 210 of the solid coalesce into three for the liquid, at Bragg angles corresponding to spacings of 5·17, 3·75, 3·05 Å. A. J. C. WILSON

548.74

1267. Electron diffraction from small crystals. C. R. BERRY. *Phys. Rev.*, **88**, 596–9 (*Nov.* 1, 1952).

Small crystals of Ag and AgBr were studied by electron diffraction. Small crystals of these materials are of interest because published experimental and theoretical considerations indicate changes in their structure which may occur. Since the diffraction theory which is applicable to large crystals cannot always be used in interpreting the photographs from materials of small size, computations were made for crystal structures and shapes which might be expected for Ag and AgBr. As a result of the computations, it was found that positions of diffraction peaks of substances having the NaCl structure depend on the crystal shape. It was also shown that the determination of particle size by the usual method of the Scherrer equation may give values which are much too small. Comparison of experimental and theoretical diffraction effects indicates that small Ag particles have the same structure as the large particles, but that there is a real contraction of the lattice in the smaller particles which amounts to 2·7% for particles with a diameter of about 31 Å. The small AgBr particles have the same structure as the large particles, and an apparent expansion of the AgBr lattice of about 1·0% appears to be best explained not as an expansion but as a particle-shape effect which changes the position of the diffraction peak. The crystals appear to be plates bounded by (111) faces, just as in many photographic emulsions, although this is not the usual form of crystals having this structure. A.

548.74

1268. Determination of inner potentials and structure factors from the fine structure of the electron-diffraction maxima of small crystals. H. J. ALTENHEIN, K. MOLIÈRE AND H. NIEHRS. Note in *Naturwissenschaften*, **39**, *No.* 19, 447–8 (1952) *In German.*

Refraction at the crystal faces splits the electron-diffraction maxima into a number of parts (15 in the case of a parallelepiped; some may be too weak for observation). Preliminary results suggest a mean potential of $15{\cdot}6 \pm 0{\cdot}3$ V and a 220 component of $5{\cdot}5 \pm 0{\cdot}4$ V for MgO. The connection between dynamic and kinematic theories is discussed.

A. J. C. WILSON

548.74 : 539.185

1269. Neutron diffraction studies of cold worked brass. R. J. WEISS, J. R. CLARK, L. CORLISS AND J. HASTINGS. *J. appl. Phys.*, **23**, 1379–82 (*Dec.*, 1952).

Powder diffraction data with neutrons have shown the integrated intensities to be identical in cold worked (filed) and annealed brass with no trace of extinction effects. Long-wavelength transmission studies have also shown that the diffuse scattering is increased by less than 0·4% upon severely cold rolling brass. A new technique of examining the Bragg discontinuities supports the hypothesis that the major part of the broadening is due to lattice distortion. Some remarks are presented concerning the analogy between long wavelength neutrons and conduction electrons with respect to scattering by dislocations. The effects of dislocations on coherent scattering are also considered. A.

GEOPHYSICS 55

550.341

1270. The nature of *T*-waves generated by submarine seisms. J. COULOMB. *Bull. Acad. Roy. Belgique Cl. Sci.*, **38**, *No.* 3, 393–6 (1952) *In French.*

It is shown that Rayleigh waves will be negligibly small under the conditions of propagation associated with short-period seismic *T*-waves. It appears impossible therefore to identify them with the latter.

D. R. BARBER

550.361

1271. Temperature of the interior of the earth. J. A. JACOBS. Letter in *Nature* [*London*] **170**, 838 (*Nov.* 15, 1952).

Assuming a linear relationship between the reciprocal of bulk compressibility, volume coeff. of thermal expansion, and pressure, an expression is found for the adiabatic temperature gradient in terms of density, and specific heat at constant pressure which is valid for all depths below 10^3 km. An estimated temperature at the boundary of the terrestrial core and mantle of 4350°K, and at the centre of the core, $\geqslant$ 4800°K, results. D. R. BARBER

550.381

1272. Terrestrial magnetism. The magnetic susceptibility of soil. E. LE BORGNE. *C.R. Acad. Sci.* [*Paris*] **235**, 1042–3 (*Nov.* 3, 1952) *In French.*

Preliminary results of a magnetic study of soils in Brittany show that the susceptibility of a surface layer of thickness less than 30 cm is much higher than that at greater depths, the variation being from about 10^{-3} to 10^{-5} e.m.u. at 100 cm depth. A. T. PRICE

550.381

1273. The electromagnetic field of a rotating uniformly magnetized sphere. A. BAÑOS, JR AND R. K. GOLDEN *J. appl. Phys.*, **23**, 1294–9 (*Dec.*, 1952).

The problem discussed here is a first step towards a more complete understanding of the modern theories of geomagnetism which are based on the differential rotation of the earth's crust with respect to its inner core and on magneto-hydrodynamical effects in the core. This paper considers first the computation of the electric and magnetic fields that a stationary observer attributes to a uniformly magnetized sphere which, in his frame of reference, rotates at constant

angular velocity about an axis parallel to the direction of magnetization. It is found that, neglecting the terms of order v^2/c^2, the observed magnetic fields are identical to the fields of the stationary sphere, but in addition there is an external electric field identical to that produced by an axial quadrupole located at the origin. The interior electric field is directed towards the axis of rotation and its magnitude is proportional to the distance from the axis. Next, when the rotating magnet is surrounded by a stationary concentric shield, it is found that the electric fields vanish in the interior of the shield and in outer space in contrast to the results that one would find on the assumption that the shield was being "cut" by the lines of magnetic induction of the rotating magnet. Finally, the limiting case is considered in which the inner radius of the shield approaches the radius of the sphere, an insulating layer still being maintained between them. Here, again, no electric fields are found outside the rotating magnet. A.

550.385 : 551.594.5

1274. Theories of magnetic storms and auroræ. J. W. DUNGEY. Letter in *Nature* [*London*] **170,** 795 (*Nov.* 8, 1952).

Examination of the theories of Alfvén and Martyn using a continuous gas model, instead of considering orbits of individual particles, reveals a difficulty concerning the acceleration of the auroral particles. The existing magnetic field will react on the gas to destroy the acceleration, except near a neutral point, such as might be produced by a combination of the permanent geomagnetic field and a field carried out by a stream from the sun. A. T. PRICE

550.389

1275. The calculation of magnetic declination in the Carpathian basin. A. TÁRCZY-HORNOCH. *Acta tech. Hungar.*, **3,** *No.* 1–2, 23–52 (1952) *In German.*

A detailed survey, and re-examination of geomagnetic observations made during the years 1863–1943, at stations in Austro-Hungary. From normalized values of declination, a value for the Carpathian basin is obtained via a fictitious station (Rozsnyó). D. R. BARBER

550.93

1276. Radiocarbon dating. W. F. LIBBY. *Chicago, University of Chicago Press* (1952) vii + 124 *pp.*

Review in *Nucleonics,* **10,** 60, 62 (*Sept.*, 1952).

551.48.018

1277. A wave-recorder for use in ships. M. J. TUCKER. *Nature* [*London*] **170,** 657–9 (*Oct.* 18, 1952).

After reviewing the various methods which have been used to record wave heights at sea (i.e. at a considerable distance from land) the author describes a method recently used on a voyage of R.R.S. *Discovery II.* The new apparatus is contained completely within the hull of the ship. In principle it measures the height of the water surface above some point on the ship's hull and the height of this point above an imaginary reference plane. The sum of the two measurements gives the height of the water surface above the reference plane, and hence is independent of the movement of the ship. The height of the water surface above the point on the ship's hull is measured by the pressure transmitted through a small hole in the ship's side, and the displacement of the point is measured by means of a vertical accelerometer the output of which is integrated twice electronically with respect to time. The paper contains some details of these arrangements and portions of actual records are reproduced. The overall accuracy is estimated at ±10%. A. B. WOOD

ATMOSPHERE . METEOROLOGY 551.5

551.501.8 : 551.594.6

1278. Joint Commission on Radio-Meteorology. International Council of Scientific Unions. Proceedings of the Second Meeting, Brussels, August 16–18, 1951. *Secrétariat Général de l'U.R.S.I.*, 42 *Rue des Minimes, Brussels* (1952) 83 *pp.*

After an introductory summary of the topics discussed, 9 papers are given in full: *Meteorological processes controlling the refractive index of the atmosphere.* P. A. Sheppard (9–17) [Abstr. 1289 (1953)]. *Thunderstorms. The electric field variations radiated from lightning discharges.* H. Norinder (17–38) [Abstr. 1294 (1953)]. *On the sources of atmospherics.* R. Bureau (41–4) [Abstr. 1298 (1953)]. *Note on the relation between the meteorological situation and the location of sferics.* A. Perlat (44–52) [Abstr. 1299 (1953)]. *Present status of research on radio-meteorology in Japan.* H. Hatakeyama (52–6) [Abstr. 1300 (1953)]. *Precipitation echoes.* J. S. Marshall (56–66) [Abstr. 1287 (1953)]. *Radar observations of natural rain.* E. G. Bowen (66–9) [Abstr. 1288 (1953)]. *Attenuation of microwaves by atmospheric gases and by rainfall.* L. J. Anderson (70–3) [Abstr. 1301 (1953)]. *Statistical fluctuations in the atmosphere.* W. E. Gordon (74–7) [Abstr. 1302 (1953)]. A paper on *Sferics,* by J. Lugéon, is reported in summary form only. Brief "remarks" by P. A. Sheppard on atmospheric turbulence are also reported.

551.510.3 : 551.524.7 : 551.547

1279. Pressures, densities, and temperatures in the upper atmosphere. *Phys. Rev.*, **88,** 1027–32 (*Dec.* 1, 1952).

Averaged and internally consistent values of atmospheric pressure, density and temperature from the ground to an altitude of 219 km have been determined and compiled by the United States groups active in upper-atmospheric research by rockets. Additional relevant data by similar groups engaged in research on meteors and on the anomalous propagation of sound are also included, particularly in a brief discussion of variations with time and with place of these three atmospheric parameters. A.

551.510.534

1280. Diurnal variation of reduced thickness, and average temperature of atmospheric ozone at low latitudes. A. KHALEQ AND A. VASSY. *C.R. Acad. Sci.* [*Paris*] **235,** 737–8 (*Oct.* 6, 1952) *In French.*

Spectrophotometric measures of O_3 absorption, made with a quartz spectrograph in Afghanistan, at 1800 m, December 1950–December 1951, when

corrected for temperature variation of relative absorption coeff., confirm Karandikar's discovery (1948) of a diurnal (noon) depression of the reduced thickness of atm. O_3. They also show the existence of an asymmetry in the O_3 values obtained in the forenoon, and afternoon for the same air-mass, a result also reported by Karandikar. The noon minimum is attributed to solar heating of the O_3 layer.

D. R. BARBER

551.510.535

1281. Dynamical phenomena in the ionospheric layers. K. BIBL. *C.R. Acad. Sci.* [*Paris*] **235,** 734–6 (*Oct.* 6, 1952) *In French.*

Results obtained at Fribourg using a new high speed ionospheric sounder with film projection have revealed several new phenomena which suggest transitory movements of ionization in the atmosphere on a large scale. The author believes that horizontal movements alone are not sufficient to account for some of the phenomena, and suggests that perturbations come from very great altitudes and are rapidly propagated to lower levels. They are dissipated in the region of minimum ionization above the *E*-layer, often giving rise to an *E2s* layer lasting several hours, and the critical frequency of *E* (correctly defined) is not influenced.

G. M. BROWN

551.510.535

1282. A lunar influence on the height of the centre of the *F*2 layer. R. EYFRIG. *C.R. Acad. Sci.* [*Paris*] **235,** 736–7 (*Oct.* 6, 1952) *In French.*

Note describing examination for a lunar effect on the factor *M*3000 which approximately characterizes the height of maximum ionization of the *F*2 layer. At Huancayo (12° S) there is a distinct lunar influence of ± 3% in local summer, very feeble in local winter. At Fribourg (48°N) there is no measurable effect, although it may be present very feebly in summer.

G. M. BROWN

551.510.535

1283. The ionospheric storm of Feb. 23–28, 1952. H. SIEDENTOPF AND A. BEHR. Note in *Naturwissenschaften,* **39,** *No.* 16, 377–8 (1952) *In German.*

The usual ionospheric, geomagnetic and radio transmission disturbances were accompanied by increased zenith light intensity and by a marked temperature increase of 30° to 40°C in the height range 24–28 km. It is suggested that there is clear evidence for disturbance at all levels of the atmosphere. A precise solar cause could not be identified with certainty although a Mögel–Dellinger radio fade-out and a long-wave disturbance occurred during the period concerned.

W. J. G. BEYNON

551.510.535 : 538.566.3

Radio-wave propagation in the ionosphere. *See Abstr.*

551.513

1284. Analyzing turbulence by means of photographs of airborne particles. A. V. HARDY. *Trans Amer. Geophys. Un,* **32,** 853–60 (*Dec.,* 1951).

A recently developed technique for obtaining experimental turbulence data by photographing lint particles floating in the air is described, and some of the problems inherent to the method discussed. The sources of error occurring in such data are enumerated and a mathematical analysis is made to determine the importance of the resultant inaccuracies.

A.

551.513.2 : 525.35

1285. The redistribution of air-masses above the oceans. F. H. VAN DEN DUNGEN, J. F. COX AND J. VAN MIEGHEM. *Bull. Acad. Roy. Belgique Cl. Sci.,* **38,** *No.* 1–2, 102–5 (1952) *In French.*

A discussion of the effects on the terrestrial moment of inertia of fluctuating ocean-levels, and horizontal pressure gradients in the oceans just below their surface.

D. R. BARBER

551.524.7 : 551.557 : 551.596.1

1286. Atmospheric winds and temperatures to 50-kilometers altitude as determined by acoustical propagation studies. J. M. RICHARDSON AND W. B. KENNEDY. *J. Acoust. Soc. Amer.,* **24,** 731–41 (*Nov.,* 1952).

An average of three measurements per month of upper atmosphere winds and temperatures was made during the period July 21, 1950, through May 31, 1951, by means of acoustical propagation studies. Field operations were centred in Wray, Colorado (40° N lat, 102° W long) and extended radially 200 km. A variation in azimuth and distance from sound source to recorder positions permitted the separation of wind and temperature components of the observed upper atmosphere sonic velocity gradients. It was found that upper winds were generally westerly and of large magnitude during the winter (autumnal to vernal equinox) and easterly and of small magnitude during the summer, with wide fluctuations during the equinoctial periods. Short-term fluctuations in the wind vector were observed to be of the same order of magnitude as the vector itself. The short-term fluctuation is now well established. A doubly periodic annual variation in temperature was observed above 25 km altitude, with mean value in agreement with accepted NACA values.

A.

551.577 : 551.501.8

1287. Precipitation echoes. J. S. MARSHALL. *Joint Commission on Radio-Meteorology* (1951) 56–66. [See Abstr. 1278 (1953)].

By suitable radar techniques it is possible accurately to locate precipitation, and to measure its rate and density. Useful results can be obtained with wavelengths down to 3 cm, although the greater sensitivity for short wavelengths is somewhat offset by lack of conformity with the conditions specified. Considerations are given to the effects of particle size, to snowflakes, and to mixtures of particles (ice and water).

G. M. BROWN

551.577 : 551.501.8

1288. Radar observations of natural rain. E. G. BOWEN. *Joint Commission on Radio-Meteorology* (1951) 66–9. [See Abstr. 1278 (1953)].

There are two general kinds of radar echoes on wavelengths of 3 or 10 cm scattered from raindrops or ice: (*a*) "band" structure showing high echo intensity just below the 0°C isotherm, (*b*) "column" structure showing vertical extension either above or below the freezing level. Rain formation in (*a*) is by the Bergeron process, in (*b*) by coalescence of cloud droplets. Photographs of each type are given.

G. M. BROWN

551.593.1

1289. Meteorological processes controlling the refractive index of the atmosphere. P. A. SHEPPARD. *Joint Commission on Radio-Meteorology* (1951) 9–17. [See Abstr. 1278 (1953)].

The chief factors which control the vertical gradients of temp. and humidity in the lower troposphere are (*a*) solar and terrestrial radiation, (*b*) turbulence (diffusion), (*c*) advection, (*d*) subsidence. These are considered separately. The effect of pressure on the refractive index of the atmosphere at any fixed level is practically constant. G. M. BROWN

551.593.11 : 551.594.221

1290. Superior mirage of lightning streaks. P. K. SEN GUPTA. Letter in *Indian J. Meteorol. Geophys.*, **3**, 161–2 (*April*, 1952).

It is suggested that temperature inversion in the upper parts of a thunder cloud produces a mirage effect which would explain reports of upward discharges from the top of the cloud into the upper atmosphere. An alternative explanation of these air discharges is given on the assumption of partial optical reflection of a cloud–cloud discharge.

R. H. GOLDE

551.593.9

1291. The influence of field of view on measurements of atmospheric transmission. H. S. STEWART AND J. A. CURCIO. *J. Opt. Soc. Amer.*, **42**, 801–5 (*Nov.*, 1952).

When transmittance of the atmosphere is determined by comparing the irradiancy of a distance light source to the calculated value for the irradiancy in vacuum, the result obtained is dependent on the field of view of the receiver. Measurements of this dependence over water have been made at sea level. For an uncollimated source, the results for any wavelength in the visible and near ultraviolet regions of the spectrum are represented approximately by the relation $T_\theta = T + 0{\cdot}5(1 - T)(1 - e^{-\theta})$, where T_θ is the transmittance at a particular wavelength measured with an instrument having a field of view θ radians in diameter, and T is the transmittance which would be obtained if unscattered light alone were accepted by the measuring equipment. Observations have been made in several wavelength regions between 3600 Å and 6235 Å for atmospheres in which the transmission for visible light was between 0·35 and 0·85 per sea mile. Two-mile and nine-mile optical paths were used. Observations of T_θ through the nine-mile path were made with a fixed field of view 13·5 degrees in diameter, and those through the two-mile path were made with several values of θ between 5° and 25°. A.

551.593.9 : 539.132 : 535.338.4

Rotation-vibration spectrum of the OH molecule in the light of the night sky. *See Abstr.* 738

551.594 : 523.78

1292. Observation of the atmospheric electric field at Khartoum during the total eclipse of the sun on 25th February 1952. A. DAUVILLIER. *C.R. Acad. Sci.* [*Paris*] **235**, 852–4 (*Oct.* 20, 1952) *In French.*

A continuous record of the field was kept for a period of 10 days containing the eclipse. The field behaves very regularly except during sandstorms and no anomalous results were observed during the eclipse.

J. M. HOUGH

551.594.1

1293. Positive and negative electric space charges in atmospheric air in fine weather. R. MÜHLEISEN. Note in *Naturwissenschaften*, **39**, *No.* 16, 376–7 (1952) *In German.*

Registration by a variety of instruments shows that variations in the fine weather field are caused by space charges produced by such phenomena as the smoke of an engine or the gases ejected by a chemical factory. The polarities of such space charges are found to agree with laboratory results. The hourly variations in summer and winter of the earth's electric field in a large town are plotted. R. H. GOLDE

551.594.21

1294. Thunderstorms. The electric field variations radiated from lightning discharges. H. NORINDER. *Joint Commission on Radio-Meteorology* (1951) 17–38. [See Abstr. 1278 (1953)].

Simultaneous operation of specially constructed c.r.o.'s at two stations has allowed variations of the electric field caused by the same lightning discharges to be recorded over the ranges 0–70 km (with stations 17 km apart) and 50–2000 km (with stations 570 km apart). The results are discussed experimentally and theoretically. Near the source there is a main quasi-periodic variation of wavelength 11 km in the pre-discharges. The analysis is simplified at greater distances when the lightning is transformed into atmospherics. G. M. BROWN

551.594.221 : 621.317.31 : 621.316.98

1295. Lightning to the Empire State Building. III. J. H. HAGENGUTH AND J. G. ANDERSON. *Pwr Apparatus Syst.*, *No.* 1, 641–9 (*Aug.*, 1952).

For previous part see *Trans Amer. Inst. Elect. Engrs*, **60**, 885–9 (*Sept.*, 1947). A summary is presented of 10 years' measurements of lightning currents. Statistical results are given of the frequency of occurrence of lightning strokes to the E.S.B.; their polarity, wave-shape, charge, and duration, both for the impulse and the continuous components of the lightning stroke. The mechanism of the upward leader-stroke process from the E.S.B. is discussed and is compared with the downward leader of strokes to open ground. The applicability of the results obtained to a lightning stroke to a transmission line is examined and an explanation is offered of the variation of the front and tail of the current wave with the type of object struck. R. H. GOLDE (R)

551.594.5

1296. Great intensity variations of Hα and effects in auroral spectrograms taken in rapid succession. L. VEGARD. Letter in *Nature* [*London*] **170**, 536–7 (*Sept.* 27, 1952).

Examples (with microphotometer tracings) are given of the large fluctuation in the intensity distribution of certain auroral lines and bands, particularly Hα, found on short-exposure spectrograms of a display taken in rapid succession from the same location. The author's theory of the "terrestrial corona" is evoked to explain the observed effects as due to the entry into the upper atmosphere of solar electric

ray-bundles composed of electrons electrostatically neutralized by pos. ions, preferably protons.

D. R. BARBER

551.594.6

1297. Long distance radiowave communication. E. HARNISCHMACHER AND K. RAWER. *C.R. Acad. Sci.* [*Paris*] **235**, 709–11 (*Oct.* 6, 1952) *In French.*

It is suggested that certain cases of ionospheric propagation on frequencies above the predicted M.U.F., particularly those in an E–W direction, are due to marked lateral deviation from the great circle path as a consequence of horizontal and vertical gradients in the ionosphere. W. J. G. BEYNON

551.594.6

1298. On the sources of atmospherics. R. BUREAU. *Joint Commission on Radio-Meteorology* (1951) 41–4. [See Abstr. 1278 (1953)] *In French.*

Continuous recording of atmospherics on 27·5 kc/s allows the principal sources of storms of large range to be grouped and mapped on a world-wide scale. From a single station near Paris the principal sources have been located in tropical Africa, S. America, Central America, Antilles, and southern U.S.A.

G. M. BROWN

551.594.6

1299. Note on the relation between the meteorological situation and the location of sferics. A. PERLAT. *Joint Commission on Radio-Meteorology* (1951) 44–52. [See Abstr. 1278 (1953)] *In French.*

Since the end of 1944 the location of sferics by the British meteorological services has enabled these to be placed on synoptic weather maps. Considerations are given to a comparison between sferics and visual observations of storms, the diurnal and annual variations in the number of sources detected, and the relation between sources and areas of horizontal wind convergence of the atmosphere. G. M. BROWN

551.594.6 : 538.566.2

1300. Present status of research on radio-meteorology in Japan. H. HATAKEYAMA. *Joint Commission on Radio-Meteorology* (1951) 52–6. [See Abstr. 1278 (1953)].

Preliminary report on meteorological (especially wind) and signal strength records made in May, 1951, for 4000 Mc/s microwave propagation over distances 74–103 km. Other investigations in progress are mentioned without results. G. M. BROWN

551.594.6 : 538.566.2

1301. Attenuation of microwaves by atmospheric gases and by rainfall. L. J. ANDERSON. *Joint Commission on Radio-Meteorology* (1951) 70–3. [See Abstr. 1278 (1953)].

The chief atmospheric gases which contribute appreciable absorption at wavelengths between 10 cm and 1 mm are molecular oxygen and water vapour. The absorption spectra of these are considered. Light to moderate rain will reduce the maximum distance over which communication can be established on 1·25 cm to one-tenth its normal value.

G. M. BROWN

551.594.6 : 551.513

1302. Statistical fluctuations in the atmosphere. W. E. GORDON. *Joint Commission on Radio-Meteorology* (1951) 74–7. [See Abstr. 1278 (1953)].

Preliminary results obtained with a special airborne refractometer for measuring turbulent fluctuations in the refractive index of the atmosphere up to 3 km altitude. The technique involves measuring the frequency difference between a reference cavity resonator and another whose cavity is filled with a sample of the air. G. M. BROWN

551.594.6 : 621.396.822 : 621.396.9

1303. Identification of tornadoes by observation of waveform atmospherics. H. L. JONES AND P. N. HESS. *Proc. Inst. Radio Engrs*, **40**, 1049–52 (*Sept.*, 1952).

The possibility of the remote detection of tornadoes by an examination of the atmospherics originating therefrom has been investigated since 1947, in the hope of providing a warning of impending danger. So far it has been found that a marked preponderance of h.f. atmospherics exists during the occurrence of a tornado as compared with those prevailing during other types of storm. The discharges causing most of these atmospherics appear to originate from a small area which includes the tornado funnel. On one occasion, when the funnel was active, the ratio of h.f. atmospherics to normal atmospherics was estimated at about 1-to-1, while before and after this activity the ratio was from 1-to-15 to 1-to-20. The equipment used to detect; to find the bearing of; and to record these atmospherics is described in detail, and typical recordings are illustrated.

A. A. LINSELL (R)

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

612.111.16 : 539.16.08

1304. Continuously recording radioactive haemoglobinometer. A. C. BURTON, R. M. RITTER AND J. H. SATTERFIELD. *Res. sci. Instrum.*, **23**, 639–41 (*Nov.*, 1952).

A radioactive method, employing haemoglobin with incorporated Fe^{59}, for continuously recording haemoglobin concentration in the blood of a living animal is described. This method records haemoglobin concentration independently of oxygenation of the blood and independently of the rate of blood flow through the apparatus. The only error that has been found in the method is statistical variation in the level of recording in accordance with the usual "shot" effect that is inherent in radioactive disintegrations. This statistical variation becomes less the greater the quantity of radioactive iron administered to the animal. For most purposes five microcuries per kilogram of Fe^{59} gives a satisfactory recording, and this quantity of radioactive iron is at

least 50 times less than the maximal safe-handling dose. A.

612.84

1305. Studies in physiological optics. N. GÜNTHER. *Optik*, **9**, *No.* 10, 441–2 (1952) *In German.*

Three basic differential equations involving the visual angle, convergence, and a sensory function are derived for use in considerations of the eye and optical instruments. R. A. WEALE

612.84 : 535.14

1306. The visual mechanism and the quantal structure of light. E. BAUMGARDT. *Naturwissenschaften*, **39**, *No.* 17, 398–93 (1952) *In German.*

This is another attempt at correlating the conclusions derived from frequency-of-seeing curves with thresholds measured during areal and temporal variations of the test-field. No new data are presented. 7 figs. R. A. WEALE

612.843.31

1307. The effect of field size and chromatic surroundings on color discrimination. W. R. J. BROWN. *J. Opt. Soc. Amer.*, **42**, 837–44 (*Nov.*, 1952).

Visual sensitivities to colour differences were determined for four colours in the presence of five surrounding fields. The colours matched were red, green, blue and white. The surrounding fields were successively red, green, blue, white and black. Colour-discrimination ellipsoids were determined for the above conditions for matching fields subtending 12 degrees and 2 degrees. Large visual fields allow better colour discrimination than fields covering only the foveal region. For small matching fields, discrimination is reduced by surrounding fields of different colour. With large (12-degree) matching fields, colour discrimination is relatively independent of the surround. A.

612.843.31

1308. Determination of the tristimulus values of the spectrum for eight Egyptian and one British observers. I. G. H. ISHAK. *J. Opt. Soc. Amer.*, **42**, 844–50 (*Nov.*, 1952).

The relative luminances of the matching stimuli were recorded with normal colour vision on Wright's colorimeter. Results for the Egyptians were compared with similar measurements made on 11 British observers and no significant differences between the means of the two sets were found. These two sets of values were found to be different from the adopted values for the C.I.E. after the transformation of the latter to the unit basis used by Wright. From the relative luminances of the matching stimuli, the spectral luminosity curve and the chromaticity co-ordinates of the eight Egyptians and the one British observer, their tristimulus values were computed in the usual manner. A marked difference in the blue values was found between the Egyptian observers and the available data for four British observers. The blue values were very low in the case of the Egyptians and the denser yellow pigmentation of the Egyptians could not account for all the differences. The spectral tristimulus values were calculated for Wright, Guild, Weaver, Abney and the C.I.E. from the combination of their data on the spectral chromaticity coordinates, together with the C.I.E. relative luminances of the matching stimuli and spectral luminosity curve. When their results were used in calculating the chromaticity of the standard sources S_A, S_B and S_C, it was found that Wright, Weaver and Abney gave results which are very close to each other but deviate considerably from Guild's results, while the C.I.E. values lie in between. A.

612.843.371

1309. The correction of low intensity luminance functions for the Purkinje effect. C. S. BRIDGMAN. *J. Opt. Soc. Amer.*, **42**, 832–6 (*Nov.*, 1952).

Under certain conditions, studies on visual thresholds as a function of luminance have indicated that the transition from cone to rod function occurs within a narrow range of luminances. This has suggested the possibility of establishing a "rod luminance scale" for lower intensities. Based on standard photopic and scotopic luminosity data, a correction curve for translating from cone to rod luminance specification has been calculated. This curve emphasizes the factors involved, but when applied to empirical data leaves residual discrepancies between rod functions determined at different wavelengths. An empirical determination of correction factors permits rectification of the luminance scale, except for a narrow transition region for each wavelength. A.

612.843.612

1310. The independence of threshold measurements of form. The stimulus area as dominant factor. J.-M. OTERO, J. YUNTA AND M. SOLIS. *Optik*, **9**, *No.* 10, 443–8 (1952) *In German.*

Frequency-of-seeing measurements of the absolute threshold of three observers reveal a linear relation between the log contrast and log area (Piper's law). For contrasts $> 90\%$ at adaptation levels of $\simeq 7\times10^{-7}$ c/cm² and for ratios r of maximum to minimum dimensions of the test-field < 4, the threshold depends only on the size of the field; the same is true for levels of $2{\cdot}3\times10^{-2}$ c/cm², also with high contrast at $r < 10$. At contrasts $< 50\%$ and the former level, the shape of the field plays a role, suggesting that the elongation of one dimension leads to the stimulation of more than one "sensory unit." R. A. WEALE

612.843.613

1311. Peripheral contrast thresholds for various and different wavelengths for adapting field and test stimulus. M. A. BOUMAN. *J. Opt. Soc. Amer.*, **42**, 820–31 (*Nov.*, 1952).

Measurements of the contrast threshold for peripheral vision for size d of the circular test spot between 4′ and 420′ and for flash time t between 0·02 and 1 sec are presented. Wavelengths for adapting field λ_1 and test stimulus λ_2 6500 and 5250 Å so that four λ_1–λ_2 combinations were explored. The merits of theoretical speculations on the perception of contrast considering the statistical fluctuations in the number of incident quanta and nerve impulses are discussed. It proved that the perception of red light is dominant over the stimulation of the rod system by the background and that the state of adaptation of the one eye and the perception of light via this eye is not affected or influenced by the actual stimulation or state of adaptation of the

opposite eye when influences due to variations in pupil size are eliminated. Exception must be made for very high brightnesses of a green background. A.

612.85 : 534.32

1312. The information of elementary auditory displays. I. POLLACK. *J. Acoust. Soc. Amer.*, **24**, 745–9 (*Nov.*, 1952).

In contrast to the extremely acute sensitivity of a human listener to discriminate small differences in the frequency or intensity between two sounds is his relative inability to identify (and name) sounds presented individually. When the frequency of a single tone is varied in equal-logarithmic steps in the range between 100 c/s and 8000 c/s (and when the level of the tone is randomly adjusted to reduce loudness cues), the amount of information transferred is about 2·3 bits per stimulus presentation. This is equivalent to perfect identification among only 5 tones. The information transferred, under the conditions of measurement employed, is reasonably invariant under wide variations in stimulus conditions. A.

612.85 : 534.321

1313. Pitch discrimination. J. D. HARRIS. *J. Acoust. Soc. Amer.*, **24**, 750–5 (*Nov.*, 1952).

A new determination was made of the way in which differential sensitivity for frequency varies both with loudness level (up to 30 phons) and with frequency (60–4000 c/s). The effect of loudness level is independent of frequency, but sensitivity (in terms of cycles discriminable) improves continuously as frequency decreases. These results are in sharp contrast with those of the most widely-quoted study in the field, and call for some reinterpretation of the relation between pitch *DL*s and such psycho-acoustic phenomena as the pitch scale, the masking of tones by noise, and frequency localization within the auditory system. A.

612.85 : 534.78

A phase-principle for complex-frequency analysis and its implications in auditory theory. *See Abstr.* 712

612.85 : 612.014.45 : 534.831

1314. Tentative estimate of a hearing damage risk criterion for steady-state noise. H. C. HARDY. *J. Acoust. Soc. Amer.*, **24**, 756–61 (*Nov.*, 1952).

The probable shape of a limiting spectrum for noise in a working environment where there is long daily exposure is determined by reasoning from previously determined data of the hearing mechanism. It is assumed that hearing loss is due to a progressive fatigue phenomenon, the fatigue being a direct function of the energy stimulus in the inner ear. From the characteristics of this stimulus as a function of frequency, it is shown that the most sensitive region for loss is around 3000 c/s, the low frequencies being as much as 20 db less sensitive than this region. The 4000 c/s "notch" in audiograms of industrial workers is thereby explained. The limiting spectra are essentially equal-loudness contours for broad-band noise when the noise spectrum is plotted in octave bands. Two limiting loudness curves and their corresponding spectra are tentatively suggested as damage risk criteria. If the noise exceeds 100 sones in any octave band, it appears very probable that long time daily exposure will result in hearing damage and in a frequency region slightly above the frequencies of maximum stimulus. If the sound does not exceed 50 sones in any octave band, it appears to be unlikely that damage will occur even with long exposure. These criteria are confirmed by the few literature references which have enough data to be used. The need for more research to test these conclusions is emphasized. A.

612.85 : 612.014.45 : 534.831

1315. New types of ear protectors. J. ZWISLOCKI. *J. Acoust. Soc. Amer.*, **24**, 762–4 (*Nov.*, 1952).

In the construction of ear plugs the chief problem is to combine the necessary sound insulation with comfort and sufficient speech intelligibility. Ear plugs are described which fulfil these requirements to a reasonable degree. They can be used for the attenuation of all audible frequencies or, with minor adaptation, as low-pass filters attenuating the more dangerous high frequencies only. For maximum speech intelligibility, both kinds of sound insulation are adequate for steady noises, whereas the low-pass filter is better for intermittent noises, detonations and noise that can be interrupted to permit communication. Extensive experiments in industry and the armed forces have shown that low-pass filters with a cut-off frequency of 1000 c/s provide sufficient hearing protection in most situations. A.

612.85 : 612.014.45 : 534.831

1316. Unsolved problems relating to hearing loss in industry. G. D. HOOPLE. *J. Acoust. Soc. Amer.*, **24**, 765–6 (*Nov.*, 1952).

Why does a noise cause hearing loss in one person and none in another? How much noise will cause a hearing loss? Noise in intensities of 120 to 150 db are conceded to be injurious to hearing. Noise less than 80 db is not a problem. Where between these two limits does noise become injurious to some ears? Noise with predominance of higher frequencies apparently is more injurious to hearing than one with predominance of low frequencies. The length of exposure to noise depends upon so many factors that it is certainly an unsolved problem. The character of the loss is an injury to the nerve of hearing and presents no problem except the differentiation between loss due to fatigue and permanent hearing loss. A.

614.898

1317. Possible industrial hazards in the use of microwave radiation. H. M. HINES AND J. E. RANDALL. *Elect. Engng*, **71**, 879–81 (*Oct.*, 1952).

Irradiation of rats and rabbits with 12 cm waves produces damage to avascular regions, including corneal opacities and degeneration of testes. Effects are probably entirely thermal and the significance in human exposure is briefly discussed. F. T. FARMER (R)

616–073 : 535.343–15

1318. The use of infrared absorption techniques in the study of hypersensitivity diseases. J. T. AGNEW, P. LISAN AND M. J. BOYD. *J. Opt. Soc. Amer.*, **42**, 815–17 (*Nov.*, 1952).

Preliminary investigations have been made of the possibility of correlating changes in i.r. absorption spectra of dried films of human blood sera with the occurrence of diseases of the hypersensitive state.

These diseases, which may include rheumatic fever, rheumatoid arthritis, asthma and many others, are thought to be due to an antigen-antibody reaction which might produce observable changes in the proteins of the circulatory system. Definite qualitative and quantitative changes have been observed comparing normal serum with various types of pathological serum. Absorption spectra of pure dried films of human albumin and γ-globulin have also been determined and some of the changes in the blood spectra are possibly explainable on the basis of an altered A/G ratio, which is known to occur. However, all of the changes cannot be explained on this basis. The films of sera, albumin and γ-globulin were air-dried at room temperature on thin disks of KRS-5, and examined in the Perkin–Elmer spectrometer in the spectral range 850–1400 cm^{-1} (7 to 12 microns). A.

616–073.75 : 621.383.8

1319. Electronic intensification of fluoroscopic images. M. C. Teves and T. Tol. *Philips tech. Rev.*, **14**, 33–43 (*Aug.*, 1952).

In order to reduce to a minimum the risk of injury to the patient as a result of X-ray examination, the X-ray dosage that the patient receives must be limited as far as is practicable. Therefore, the attainable brightness of the image on a standard fluoroscopic screen is so low that long visual adaptation periods are required before such images can be studied; even then, visual acuity and the contrast sensitivity of the eye are both fairly low at such low brightness levels. Improvement can be effected by increasing the brightness of the fluoroscopic image ("intensifying"). The electron tube by means of which this is now made possible functions on the principle of the image convertor. The X-rays produce on a fluoroscopic screen an image whose radiation liberates electrons from a photocathode in contact with the screen. The electrons are focused by an electrostatic electronic lens system working at a potential of 25 kV, to produce another image, reduced 9 times in size, on a second fluorescent screen, the viewing screen, which is observed through a simple microscope of 9 × magnification. The gain in brightness, to a factor of 800–1200 with respect to normal fluoroscopy, is produced partly by the accelerating field which imparts energy to the electrons, and partly by the electron-optical reduction of the fluoroscopic image. The resolving power of the image intensifier is higher than that of the best fluoroscopic screen. Owing to a number of causes the ultimate image is subject to a certain amount of fogging, which does not seriously reduce the contrast. From a discussion of the lower limit of perceptible detail as based on spontaneous fluctuation in the number of X-ray and light quanta it is seen that the brightness can be intensified up to a factor of about 20 with a corresponding increase in the amount of "information" to be derived from the image. A.

TECHNICAL MATERIALS 66/67

665.5 : 535

1320. Optics in the oil industry. P. D. Foote. *J. Opt. Soc. Amer.*, **42**, 886–97 (*Dec.*, 1952).

The greatest concentration of optical applications is in spectroscopy. Emission spectroscopy is widely used in almost all operations for rapid reliable analysis of materials for metallic or inorganic elements. The techniques of i.r. and u.v. absorption spectroscopy are quite widely used to solve many analytical and molecular structure problems encountered in hydrocarbon chemistry. A specialized branch of infrared absorption wherein the selective absorption properties of gases are utilized is becoming of great importance for the continuous monitoring and automatic control of refining processes. An indirect but extremely important application of optics is in the utilization of thermodynamic quantities derived from spectroscopic data. Various aspects of photochemistry and optical activity are important. It has been found practical and convenient to utilize ultraviolet light in accelerated stability tests of products subject to deterioration with age. At present it is known that a hydrocarbon of phenomenal octane number may be prepared by photochemical synthesis. In the study of compounds isolated from petroleum it has been discovered that some of them are optically active. At least one of these has been isolated and studied. Aerial photography occupies a very important place in the mapping work involved in exploration and pipe-line surveys. A field allied to mapping and employing the concepts, if not the equipment, of optics is in radiolocation wherein either direct interferometric techniques or time measurements of wave propagation are employed. Other sciences utilizing common optical concepts, X-ray diffraction, electron diffraction, electron microscopy and mass spectrometry, are also essential to petroleum industry research. A.

666

1321. Physical properties of glass. J. E. Stanworth. *London, Oxford University Press*, vii + 224 *pp.*

Review in *Brit. J. appl. Phys.*, **3**, 366 (*Nov.*, 1952).

669

1322. Simple h.f. furnace technique for fusing alloys from volatile components. A. J. P. Meyer and P. Taglang. Letter in *J. Phys. Radium*, **13**, 485 (*Oct.*, 1952) *In French.*

The components are fused in a refractory tube closed by a magnesia bung. This crucible is placed in a silica tube which is closed by a shorter but concentric tube. The tops of these tubes are sealed together with wax, and the whole assembly is placed within the h.f. field. Alloys of the following types have been fused satisfactorily without loss: Co–Zn, Mn–Zn, Mn–As, Mn–Bi, Fe–P, Co–B. E. H. Dock

PHOTOGRAPHY 77

77.01 : 53.087.5

1323. Applications of Fourier integrals to photographic images. I and II. J. GAULTIER DU MARACHE. *Cahiers de Phys., No.* 39, 1–56 (*Sept.*, 1952) *In French.*

The laws of photographic recording are investigated by comparing the Fourier transforms of the object and the photographic image. The objects used are the diffraction patterns due to lined process screens. Pt I gives experimental details and derives the intensity distribution in the aerial image. R. W. FISH

771.535 : 539.165

Intensification of the latent photographic image produced by beta-rays. *See Abstr.* 1077

778.34 : 539.17

T-tracks in nuclear emulsions. *See Abstr.* 1102

778.34 : 539.17

Measurements of grain density of tracks due to energetic particles recorded in photographic emulsions. Determination of minimum ionization. *See Abstr.* 1103

778.37 : 778.5

1324. An improved technique for high-speed photography. D. A. SENIOR AND C. O. J. GROVE-PALMER. *Brit. J. appl. Phys.*, **3**, 318–21 (*Oct.*, 1952).

A technique is described for high-speed cine-photography of the phenomena which take place when small explosive charges are fired under water. At the same time, the explosive pressures are recorded by piezo-electric technique. Pressure records are obtained for a period of 60 msec, and high-speed photographs taken by means of a 16 mm Fastax camera at speeds up to 4000 frames/sec. At the maximum speed, a cine record in black and white or colour is obtained for a period of 80 msec. The layout of equipment is described, and details of time marking and sequence timing arrangements are given. A.

778.37 : 778.5 : 532.525

1325. The development of a multi-flash camera and its application to the study of liquid jets. M. A. MAHROUS. *Brit. J. appl. Phys.*, 3, 329–31 (*Oct.*, 1952).

An apparatus to operate a micro-flash tube a number of times in rapid succession is described and applied to obtain cinematograph pictures of a water-jet at a number of stations along its length. As the speed of efflux is increased, three stages in the form of the jet may be discerned in which (i) the jet becomes varicose, (ii) it becomes sinuous and (iii) pieces are sheared off the sides by friction with the air. It appears that, below speeds of the order 20 m/sec, the liquid always breaks into pieces of a size comparable with the width of the jet. Subsequent break-up of individual drops into smaller units occurs owing to their high speed through the air. A.

778.6

1326. Theory of masking for color correction. I. Masks drawn from the subject. H. E. J. NEUGEBAUER. *J. Opt. Soc. Amer.*, **42**, 740–7 (*Oct.*, 1952).

A method for colour correction is considered using 2 masks drawn from the subject and used for correcting the colour separation negatives. The formulae for computing the exposure times and the gradations are in agreement with practical results, as far as letter-press, offset and gravure printing are concerned. The exposure times of the masks and the red separation have to be carefully watched. The method allows accurate reproduction of the 8 main colours, white, yellow, magenta, cyan, violet, green, orange and black, and of a medium grey. The colours lying between them are reproduced with an approximation that is sufficient for many practical applications. The rule that the 3 colour separations have to be developed to the same gamma does not always allow a correct reproduction of grey. The reproduction of greys can be considerably improved by making use of non-linear characteristic curves. This is valid for letter-press, offset and gravure printing as well as for reproduction methods based on subtractive mixture. A.